FIG. 1

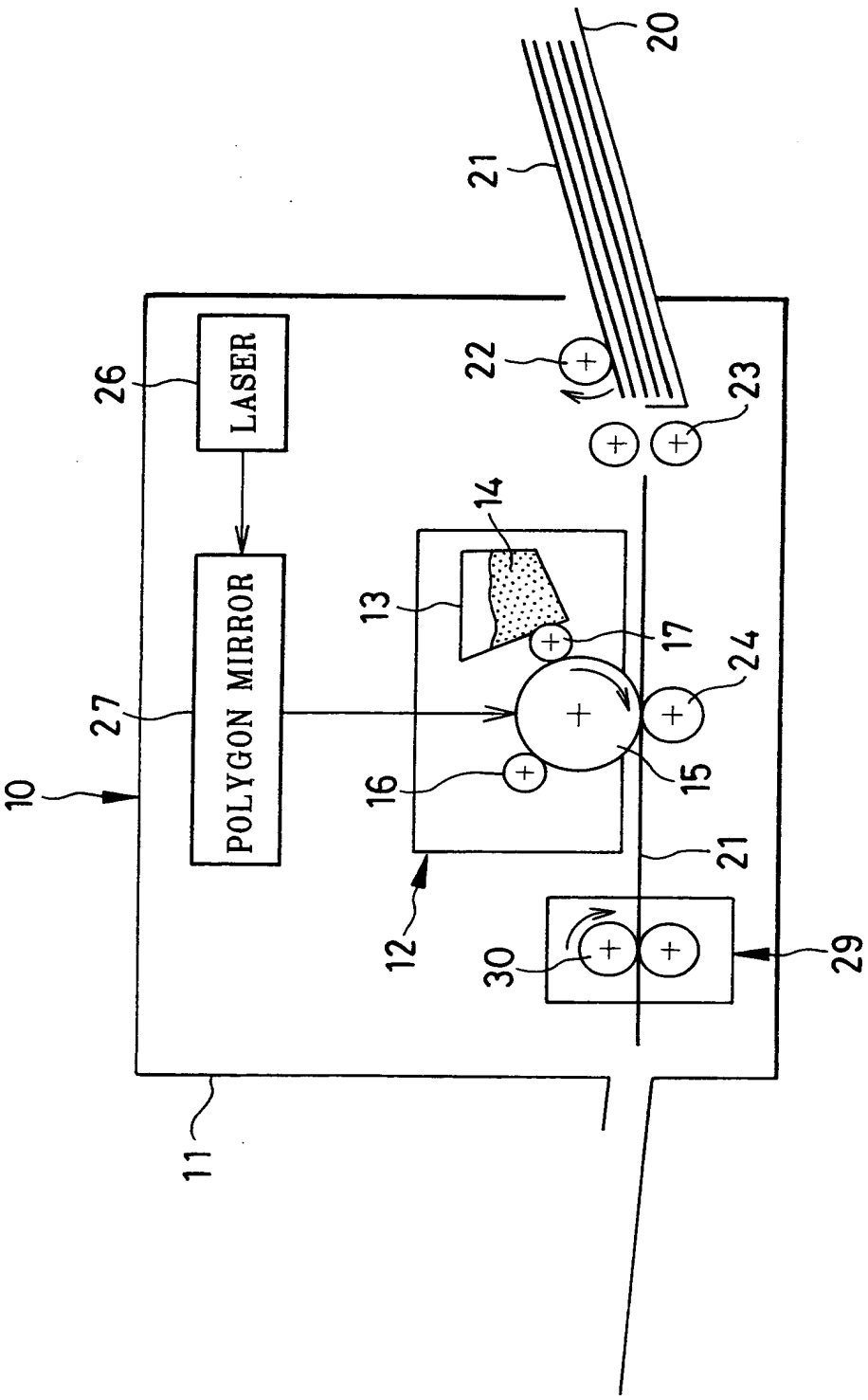

LASER
POLYGON MIRROR
10
11
12
13
14
15
16
17
20
21
22
23
24
26
27
29
30

FIG. 2

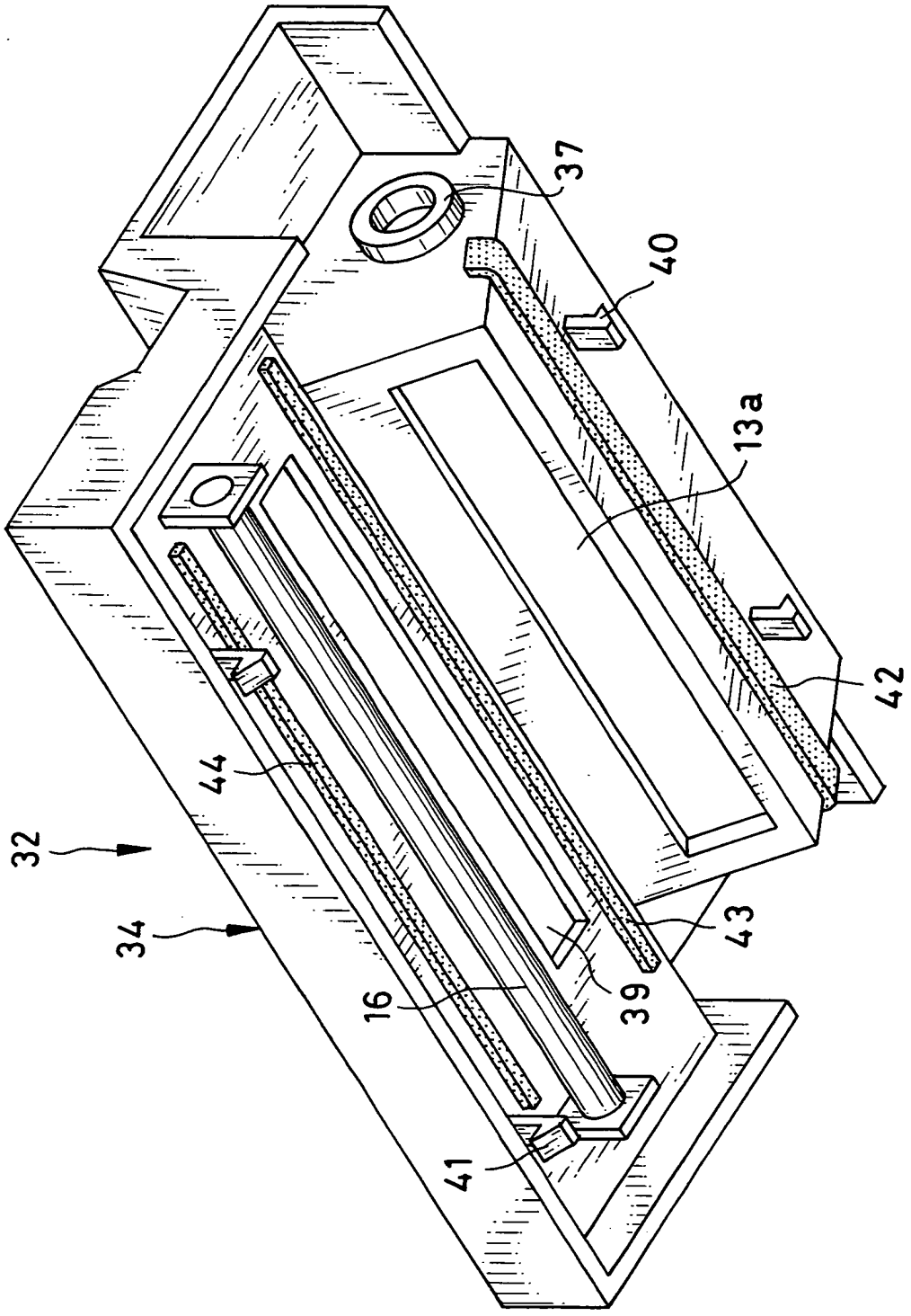


FIG. 3

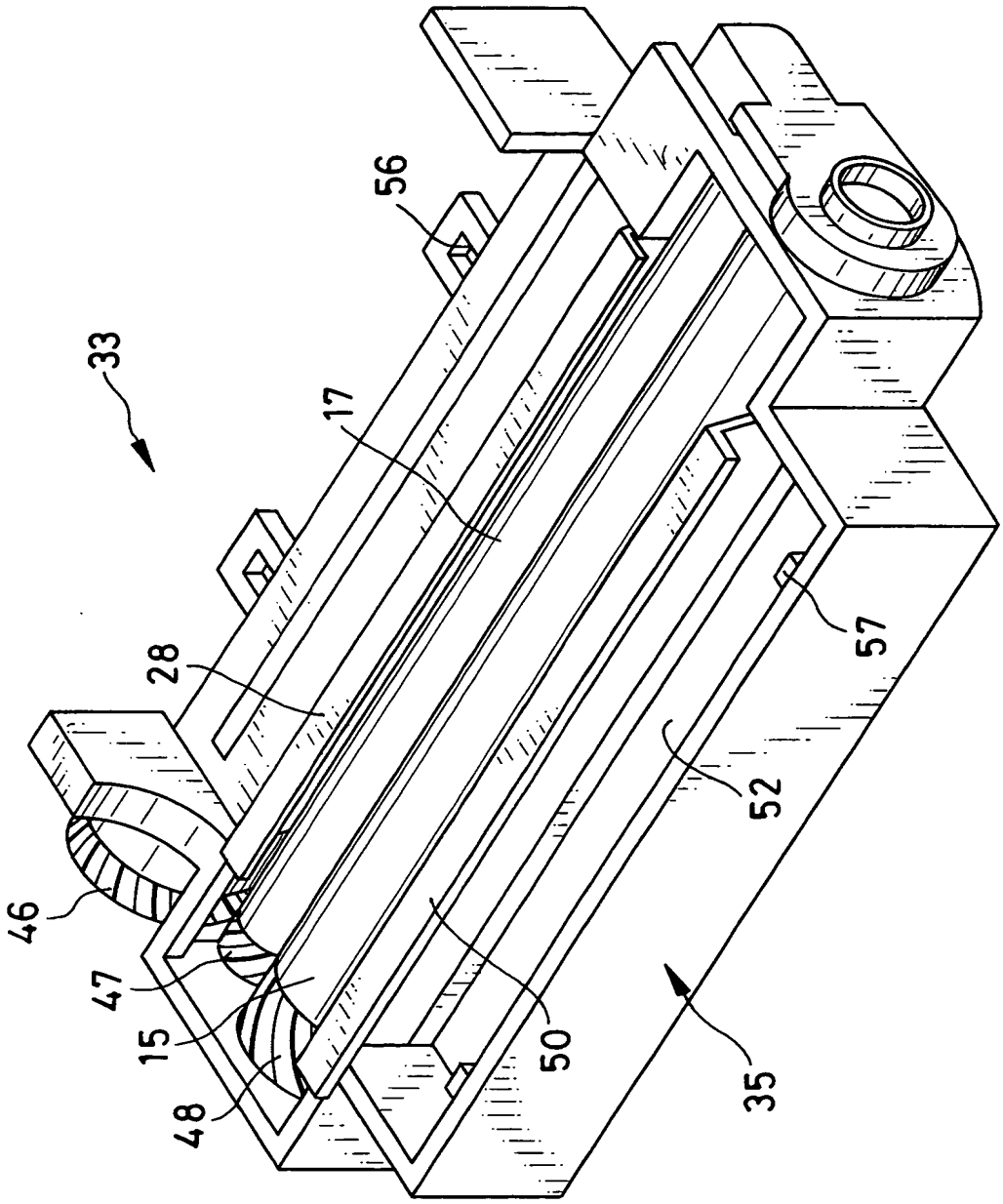


FIG. 4

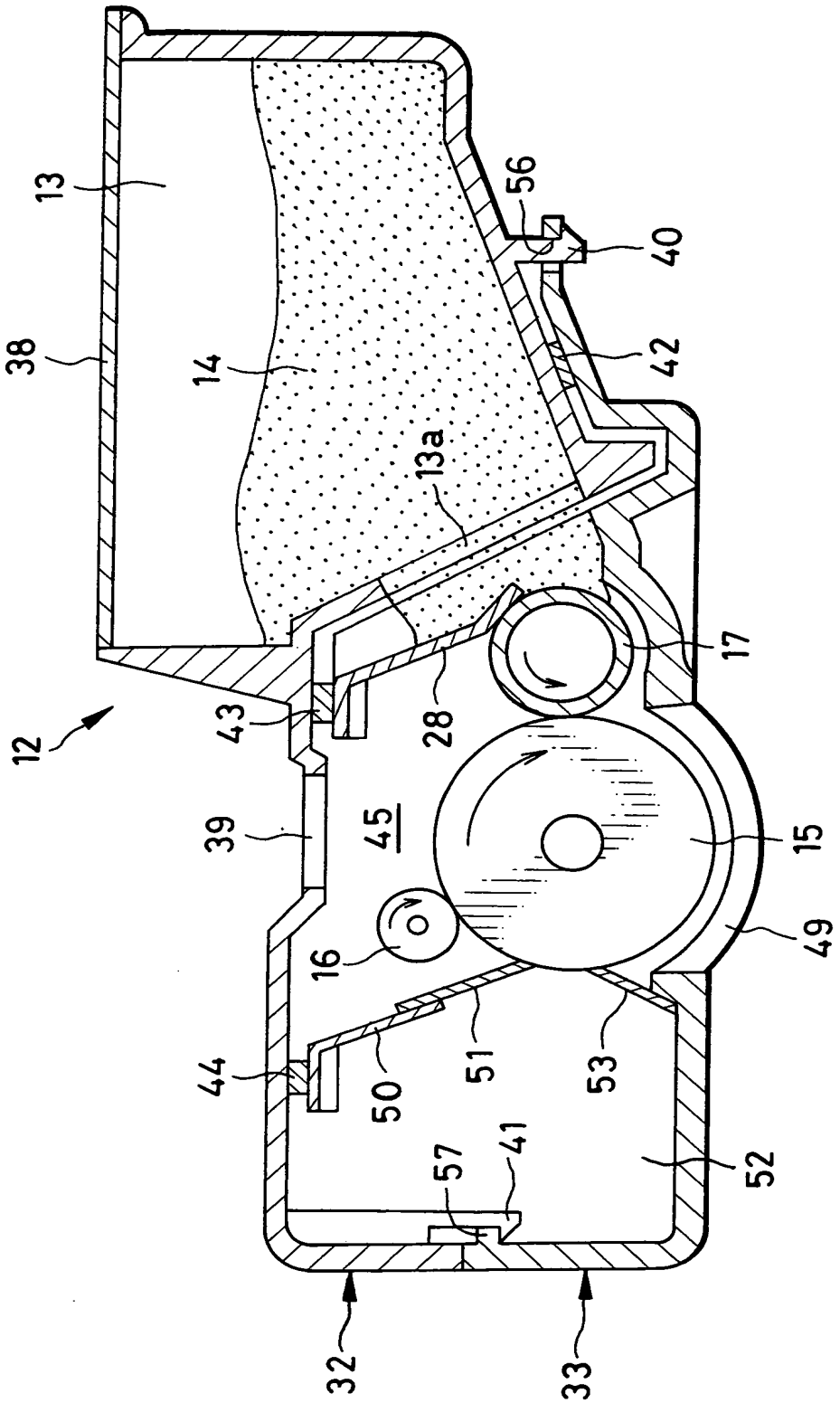

13
38
14
13a
56
40
42
17
12
43
28
39
45
15
16
49
44
50
51
53
52
57
41
32
33

FIG. 5

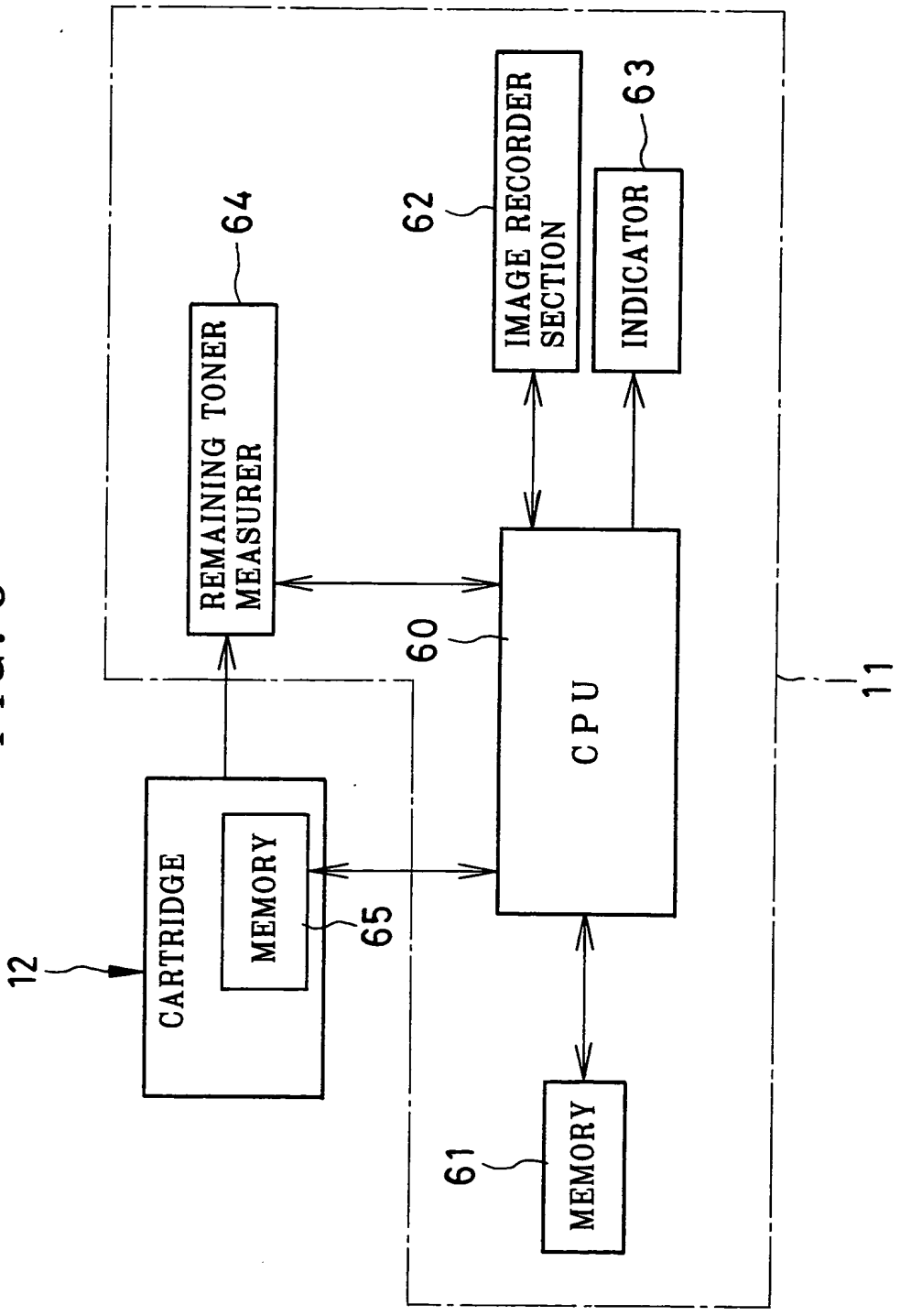

11
CPU
60
MEMORY
61
IMAGE RECORDER SECTION
62
INDICATOR
63
REMAINING TONER MEASURER
64
CARTRIDGE
12
MEMORY
65

FIG. 6

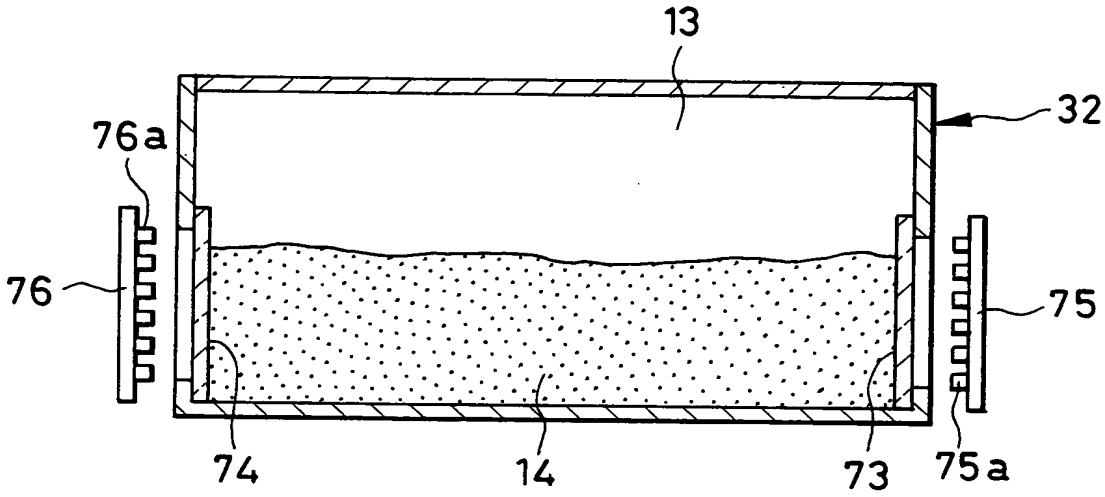


FIG. 11

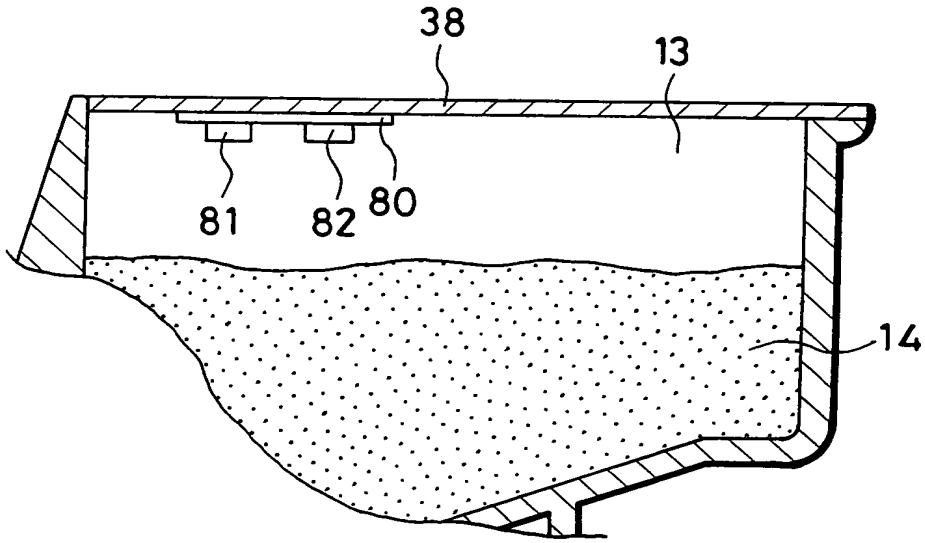


FIG. 7

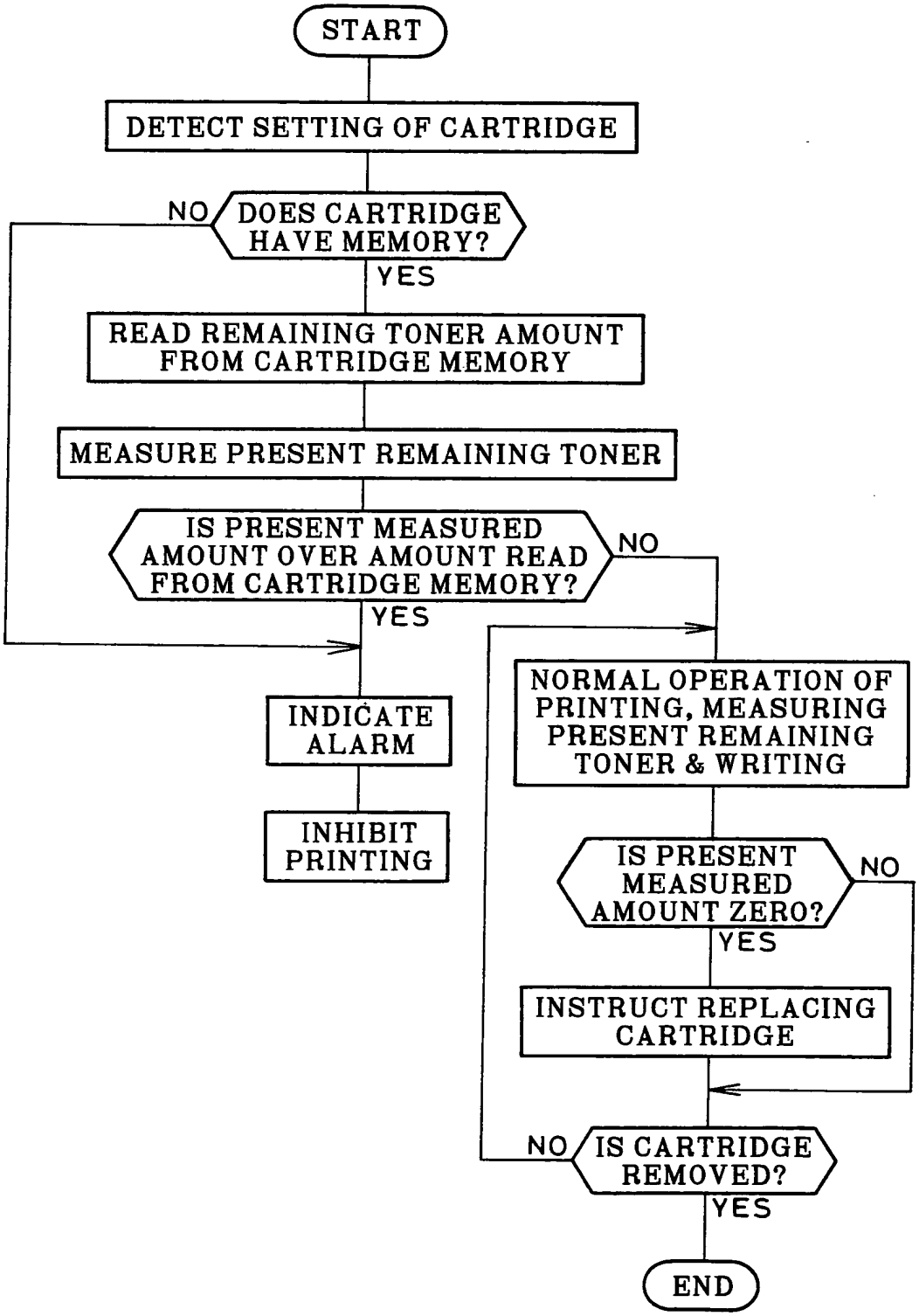

START
DETECT SETTING OF CARTRIDGE
NO
DOES CARTRIDGE HAVE MEMORY?
YES
READ REMAINING TONER AMOUNT FROM CARTRIDGE MEMORY
MEASURE PRESENT REMAINING TONER
IS PRESENT MEASURED AMOUNT OVER AMOUNT READ FROM CARTRIDGE MEMORY?
NO
YES
INDICATE ALARM
INHIBIT PRINTING
NORMAL OPERATION OF PRINTING, MEASURING PRESENT REMAINING TONER & WRITING
IS PRESENT MEASURED AMOUNT ZERO?
NO
YES
INSTRUCT REPLACING CARTRIDGE
NO
IS CARTRIDGE REMOVED?
YES
END

FIG. 8

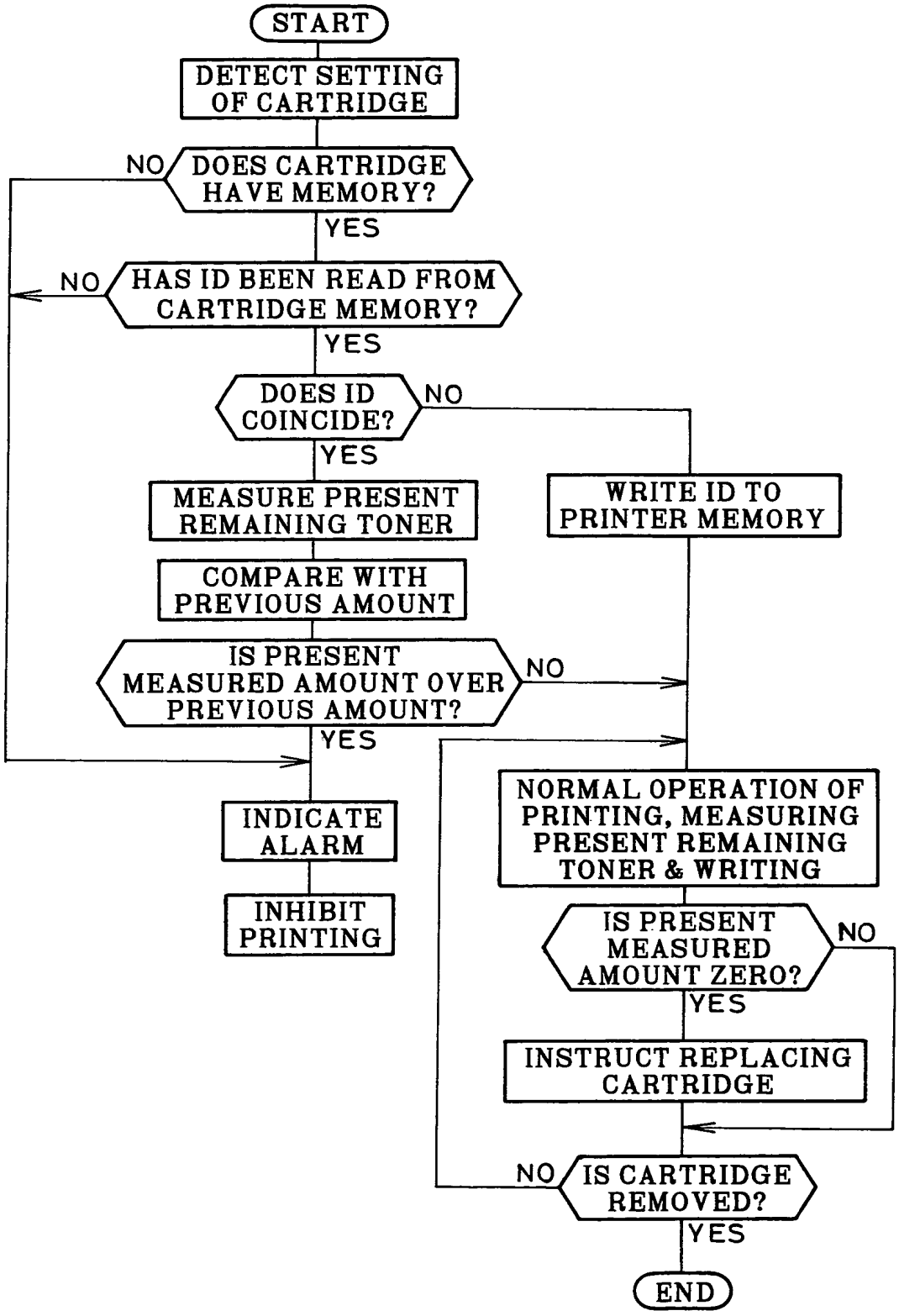

START
DETECT SETTING OF CARTRIDGE
DOES CARTRIDGE HAVE MEMORY?
NO
YES
HAS ID BEEN READ FROM CARTRIDGE MEMORY?
NO
YES
DOES ID COINCIDE?
NO
YES
MEASURE PRESENT REMAINING TONER
COMPARE WITH PREVIOUS AMOUNT
IS PRESENT MEASURED AMOUNT OVER PREVIOUS AMOUNT?
NO
YES
INDICATE ALARM
INHIBIT PRINTING
WRITE ID TO PRINTER MEMORY
NORMAL OPERATION OF PRINTING, MEASURING PRESENT REMAINING TONER & WRITING
IS PRESENT MEASURED AMOUNT ZERO?
NO
YES
INSTRUCT REPLACING CARTRIDGE
IS CARTRIDGE REMOVED?
NO
YES
END

FIG. 9

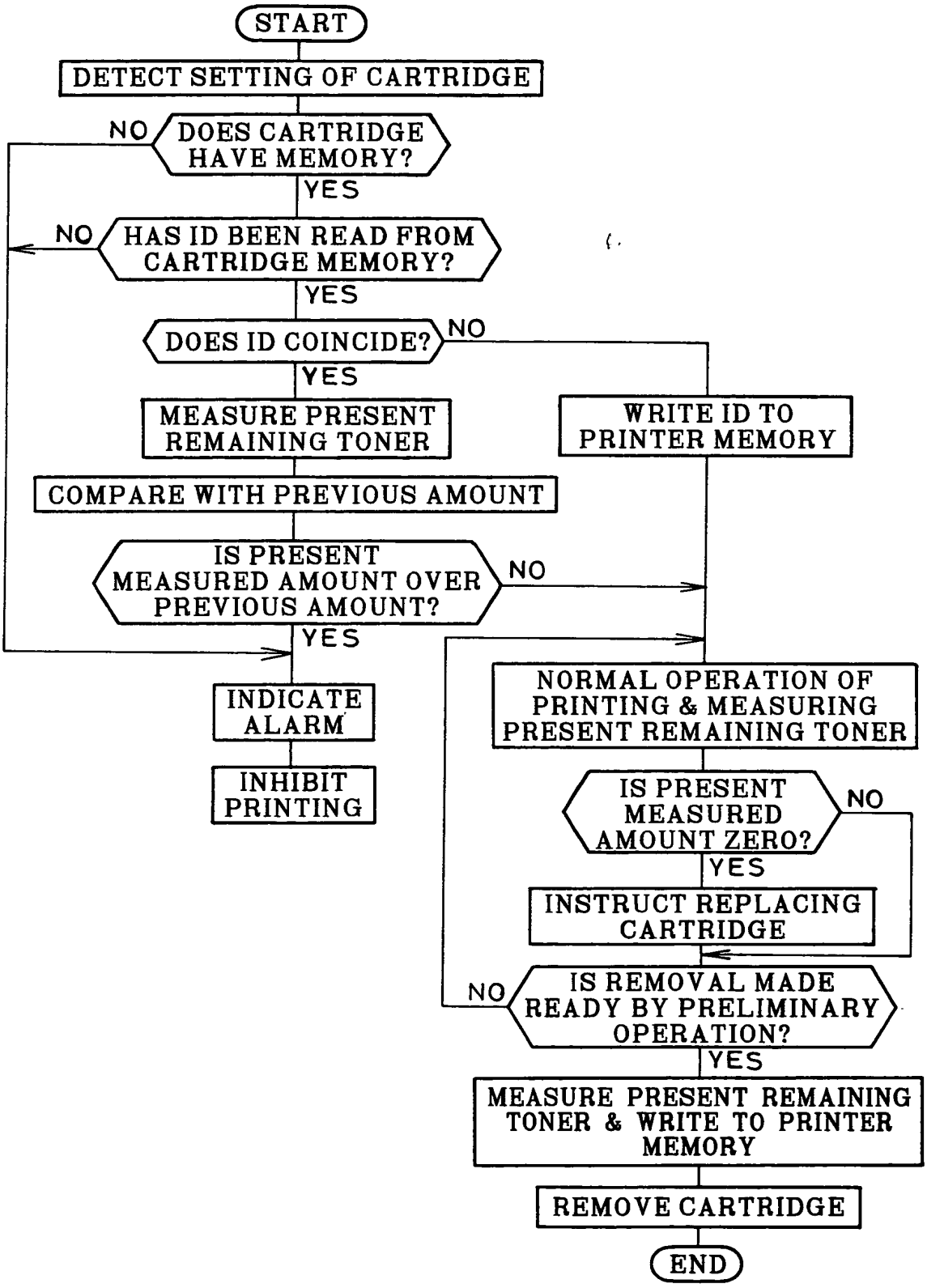

START
DETECT SETTING OF CARTRIDGE
DOES CARTRIDGE HAVE MEMORY?
NO
YES
HAS ID BEEN READ FROM CARTRIDGE MEMORY?
NO
YES
DOES ID COINCIDE?
NO
YES
MEASURE PRESENT REMAINING TONER
WRITE ID TO PRINTER MEMORY
COMPARE WITH PREVIOUS AMOUNT
IS PRESENT MEASURED AMOUNT OVER PREVIOUS AMOUNT?
NO
YES
INDICATE ALARM
INHIBIT PRINTING
NORMAL OPERATION OF PRINTING & MEASURING PRESENT REMAINING TONER
IS PRESENT MEASURED AMOUNT ZERO?
NO
YES
INSTRUCT REPLACING CARTRIDGE
IS REMOVAL MADE READY BY PRELIMINARY OPERATION?
NO
YES
MEASURE PRESENT REMAINING TONER & WRITE TO PRINTER MEMORY
REMOVE CARTRIDGE
END

FIG. 10

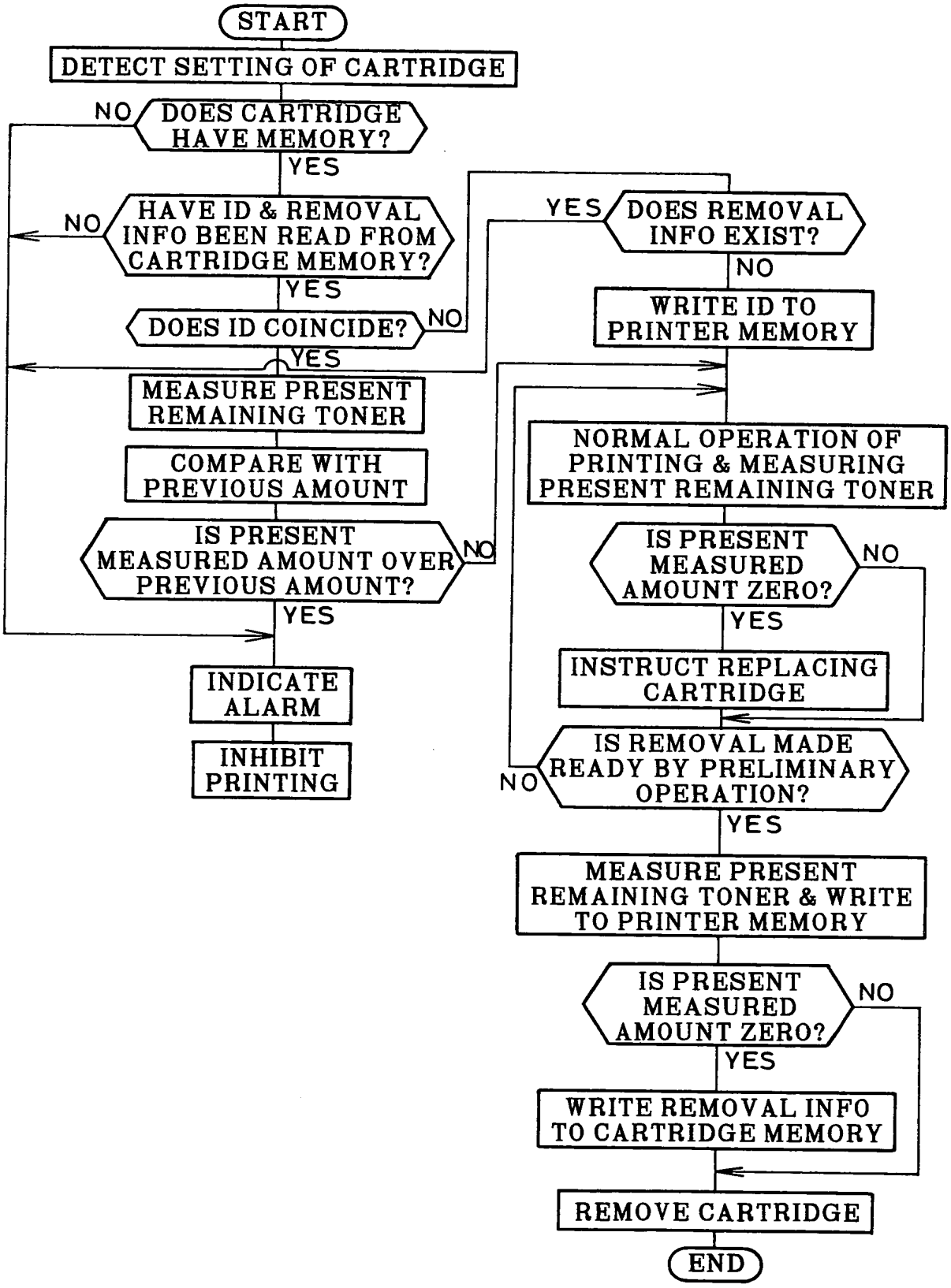

START
DETECT SETTING OF CARTRIDGE
DOES CARTRIDGE HAVE MEMORY?
NO
YES
HAVE ID & REMOVAL INFO BEEN READ FROM CARTRIDGE MEMORY?
NO
YES
DOES ID COINCIDE?
NO
YES
MEASURE PRESENT REMAINING TONER
COMPARE WITH PREVIOUS AMOUNT
IS PRESENT MEASURED AMOUNT OVER PREVIOUS AMOUNT?
NO
YES
INDICATE ALARM
INHIBIT PRINTING
YES
DOES REMOVAL INFO EXIST?
NO
WRITE ID TO PRINTER MEMORY
NORMAL OPERATION OF PRINTING & MEASURING PRESENT REMAINING TONER
IS PRESENT MEASURED AMOUNT ZERO?
NO
YES
INSTRUCT REPLACING CARTRIDGE
IS REMOVAL MADE READY BY PRELIMINARY OPERATION?
NO
YES
MEASURE PRESENT REMAINING TONER & WRITE TO PRINTER MEMORY
IS PRESENT MEASURED AMOUNT ZERO?
NO
YES
WRITE REMOVAL INFO TO CARTRIDGE MEMORY
REMOVE CARTRIDGE
END

FIG. 12

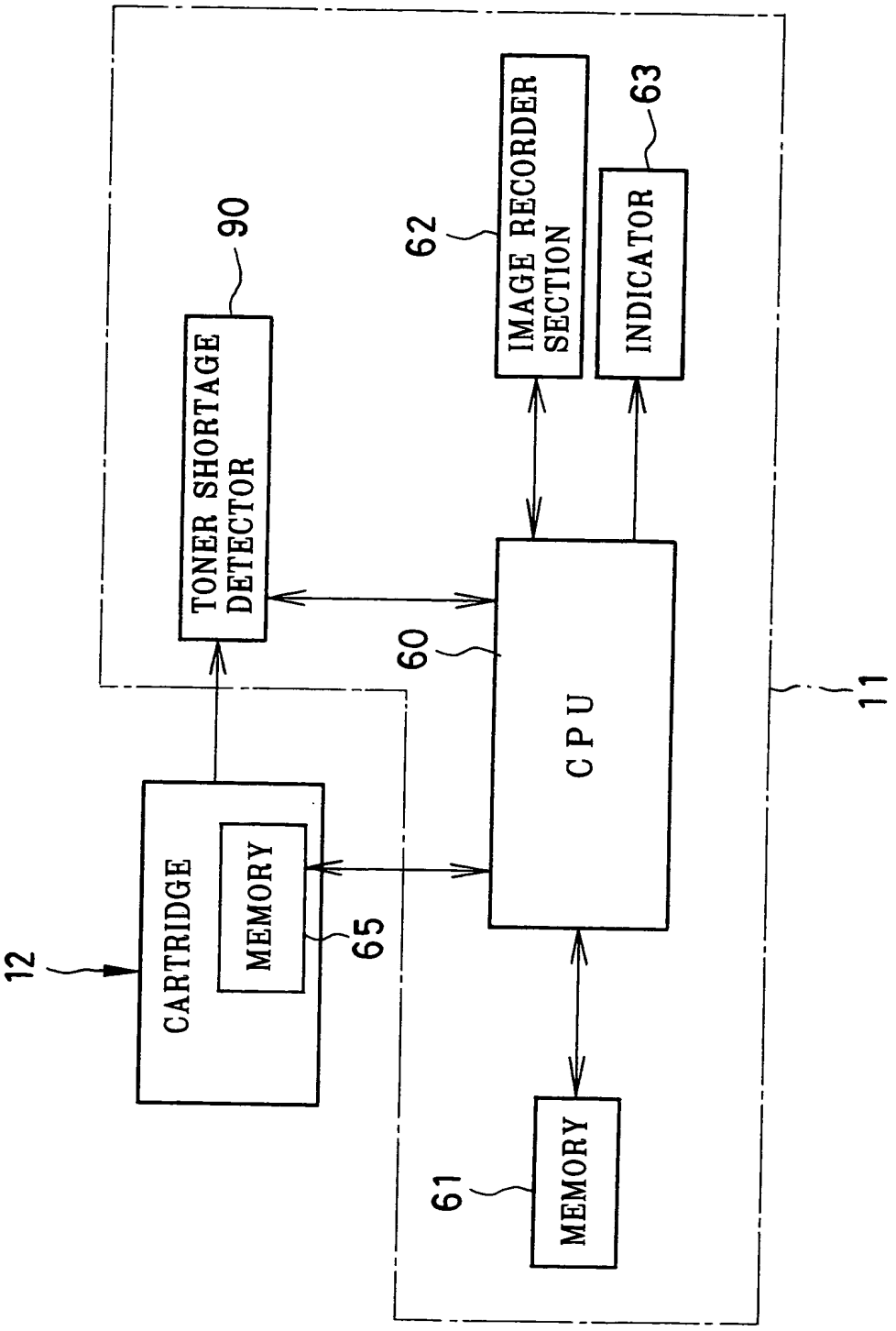

11
CPU
60
TONER SHORTAGE DETECTOR
90
IMAGE RECORDER SECTION
62
INDICATOR
63
CARTRIDGE
12
MEMORY
65
MEMORY
61

FIG. 13

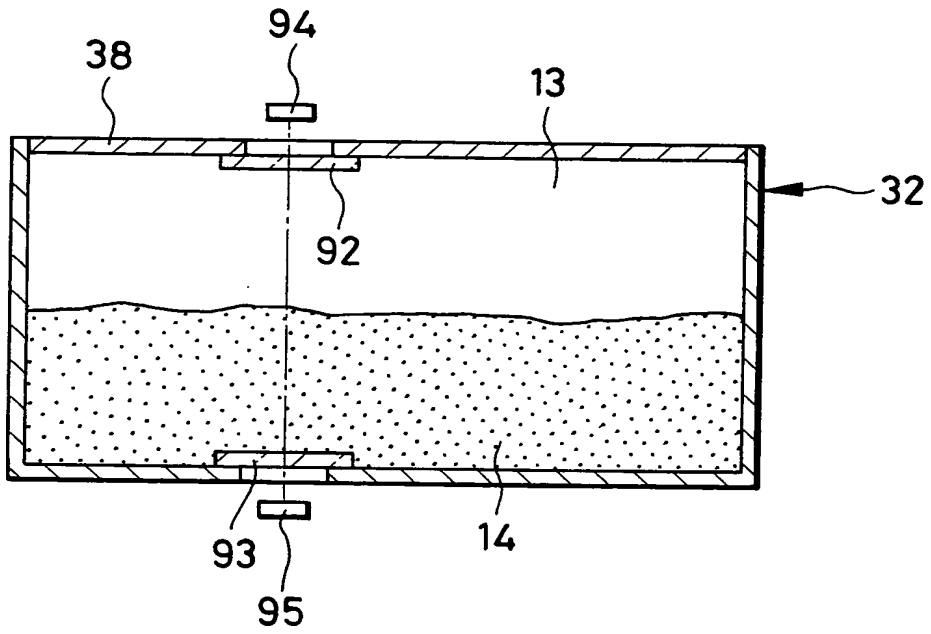


FIG. 14

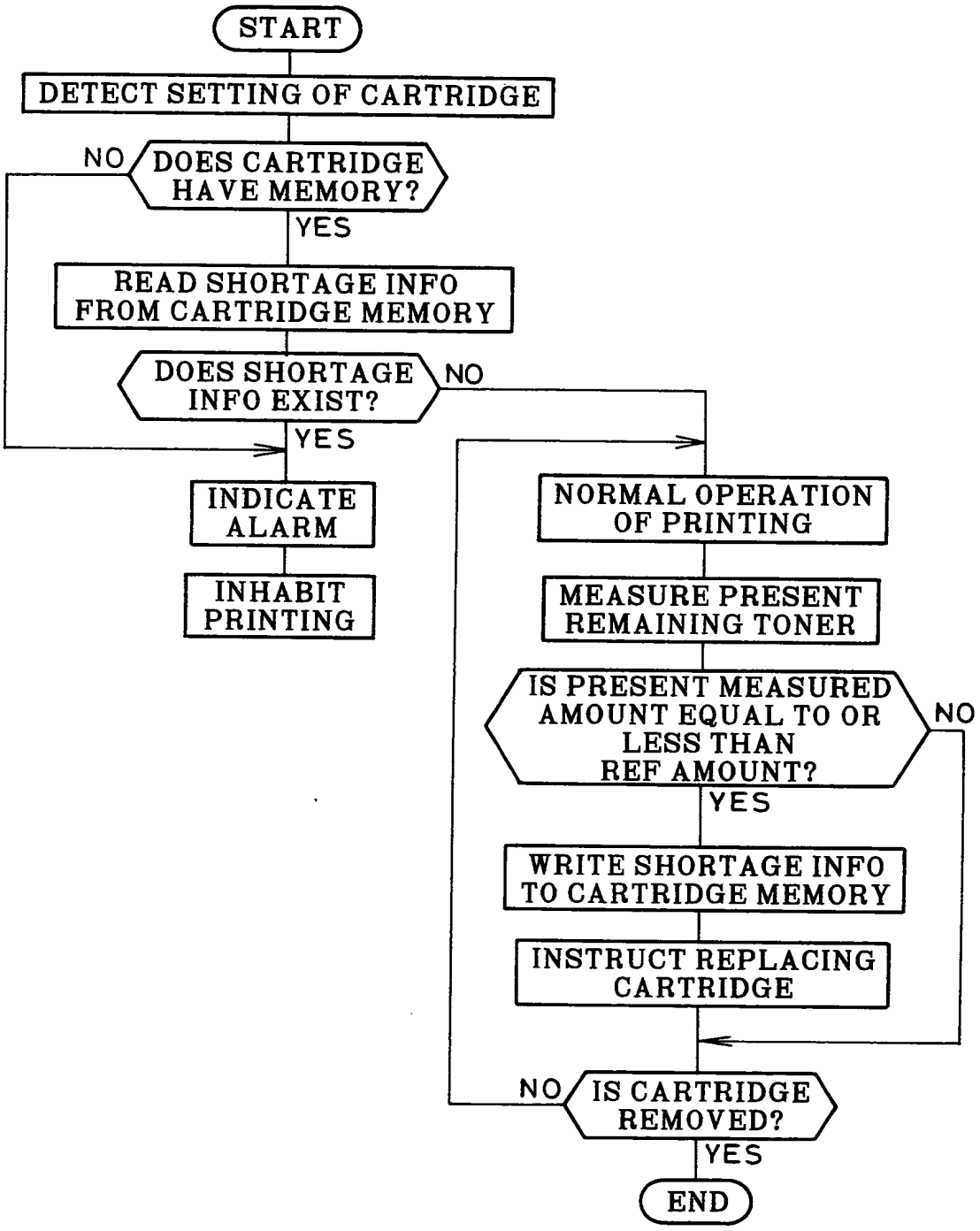

START
DETECT SETTING OF CARTRIDGE
NO
DOES CARTRIDGE HAVE MEMORY?
YES
READ SHORTAGE INFO FROM CARTRIDGE MEMORY
DOES SHORTAGE INFO EXIST?
NO
YES
INDICATE ALARM
INHABIT PRINTING
NORMAL OPERATION OF PRINTING
MEASURE PRESENT REMAINING TONER
IS PRESENT MEASURED AMOUNT EQUAL TO OR LESS THAN REF AMOUNT?
NO
YES
WRITE SHORTAGE INFO TO CARTRIDGE MEMORY
INSTRUCT REPLACING CARTRIDGE
NO
IS CARTRIDGE REMOVED?
YES
END

FIG. 15

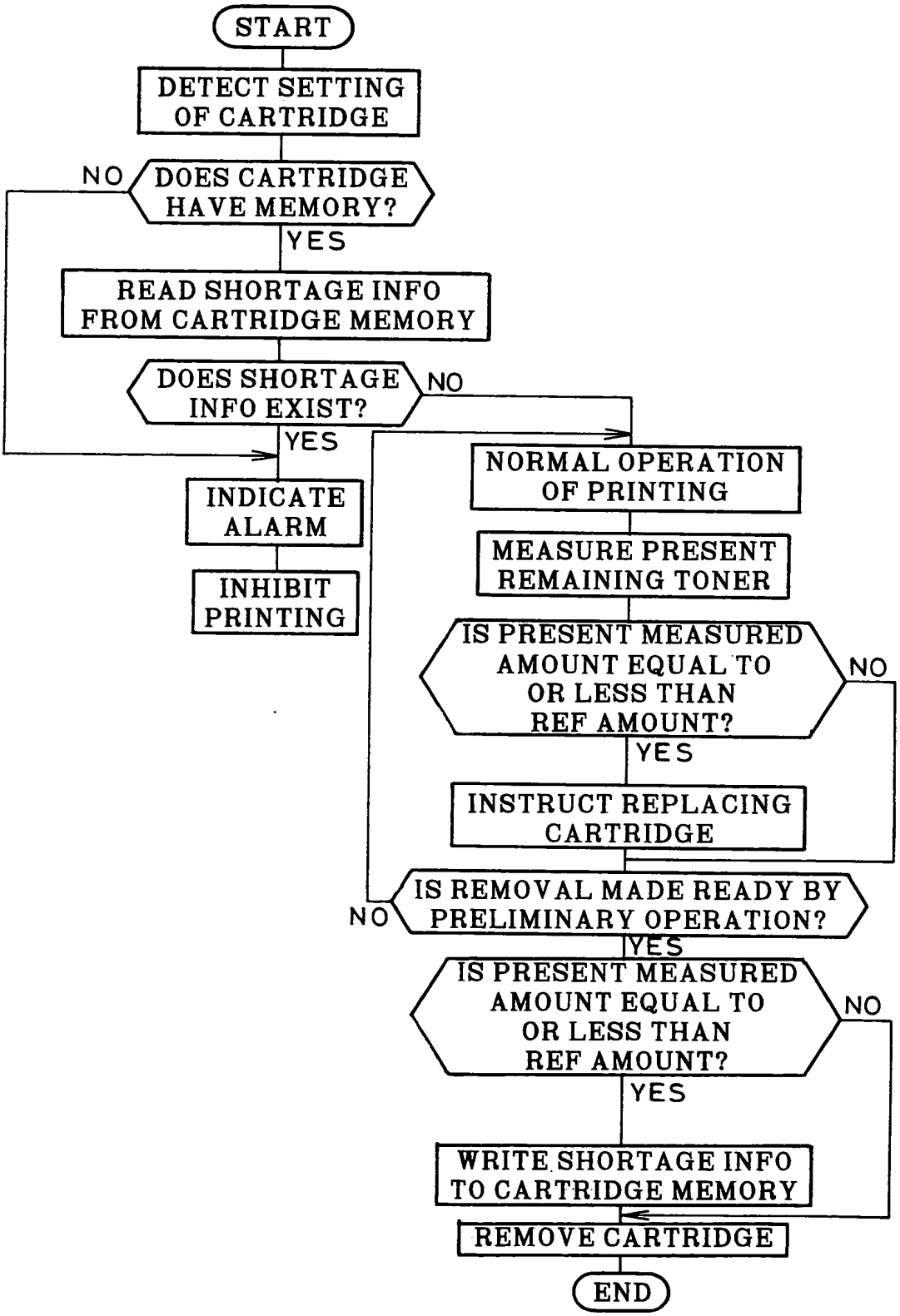

START
DETECT SETTING OF CARTRIDGE
DOES CARTRIDGE HAVE MEMORY?
NO
YES
READ SHORTAGE INFO FROM CARTRIDGE MEMORY
DOES SHORTAGE INFO EXIST?
NO
YES
INDICATE ALARM
INHIBIT PRINTING
NORMAL OPERATION OF PRINTING
MEASURE PRESENT REMAINING TONER
IS PRESENT MEASURED AMOUNT EQUAL TO OR LESS THAN REF AMOUNT?
NO
YES
INSTRUCT REPLACING CARTRIDGE
IS REMOVAL MADE READY BY PRELIMINARY OPERATION?
NO
YES
IS PRESENT MEASURED AMOUNT EQUAL TO OR LESS THAN REF AMOUNT?
NO
YES
WRITE SHORTAGE INFO TO CARTRIDGE MEMORY
REMOVE CARTRIDGE
END

FIG. 16

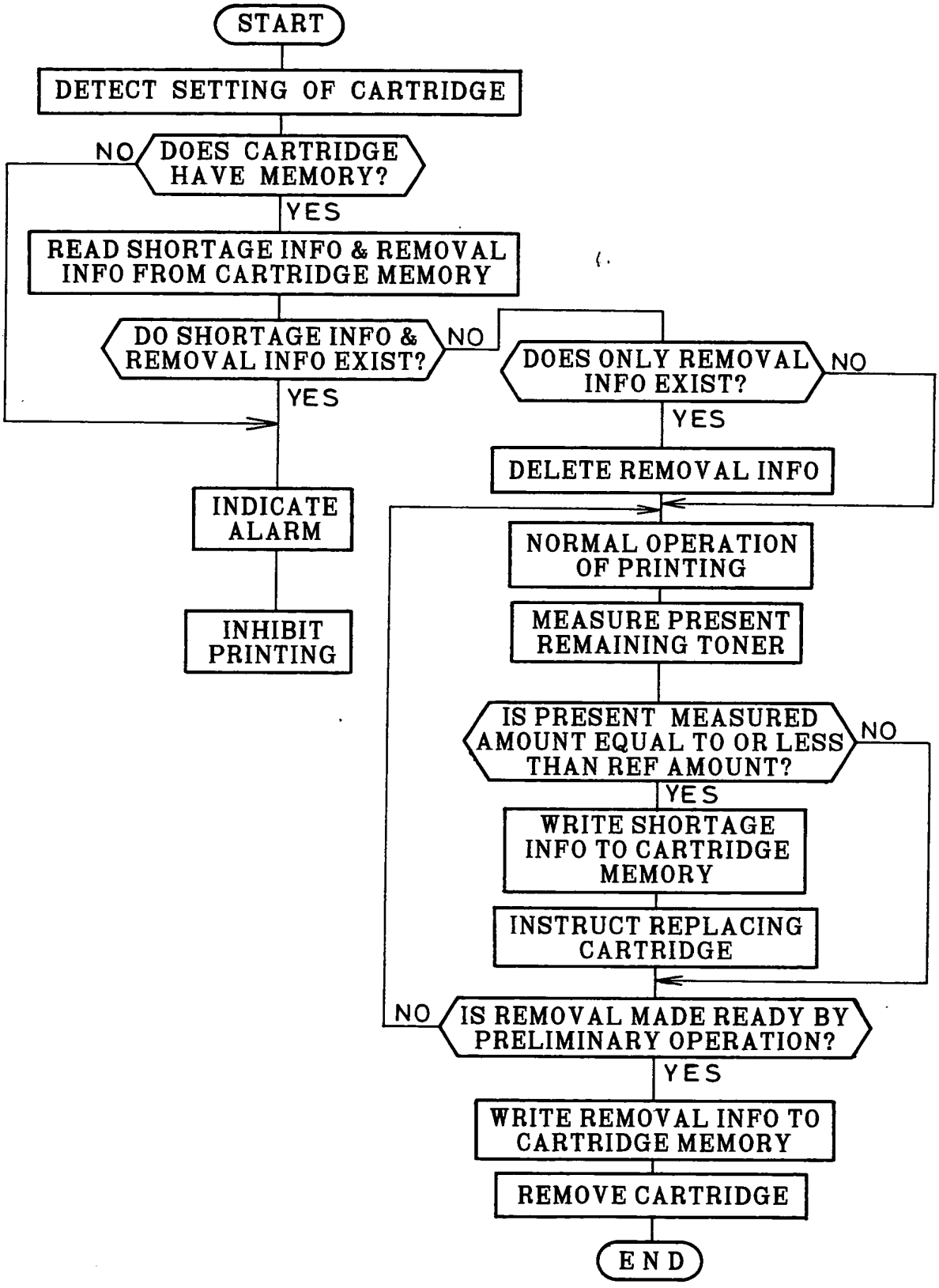

START
DETECT SETTING OF CARTRIDGE
DOES CARTRIDGE HAVE MEMORY?
NO
YES
READ SHORTAGE INFO & REMOVAL INFO FROM CARTRIDGE MEMORY
DO SHORTAGE INFO & REMOVAL INFO EXIST?
NO
YES
DOES ONLY REMOVAL INFO EXIST?
NO
YES
DELETE REMOVAL INFO
INDICATE ALARM
INHIBIT PRINTING
NORMAL OPERATION OF PRINTING
MEASURE PRESENT REMAINING TONER
IS PRESENT MEASURED AMOUNT EQUAL TO OR LESS THAN REF AMOUNT?
NO
YES
WRITE SHORTAGE INFO TO CARTRIDGE MEMORY
INSTRUCT REPLACING CARTRIDGE
NO
IS REMOVAL MADE READY BY PRELIMINARY OPERATION?
YES
WRITE REMOVAL INFO TO CARTRIDGE MEMORY
REMOVE CARTRIDGE
END

FIG. 17

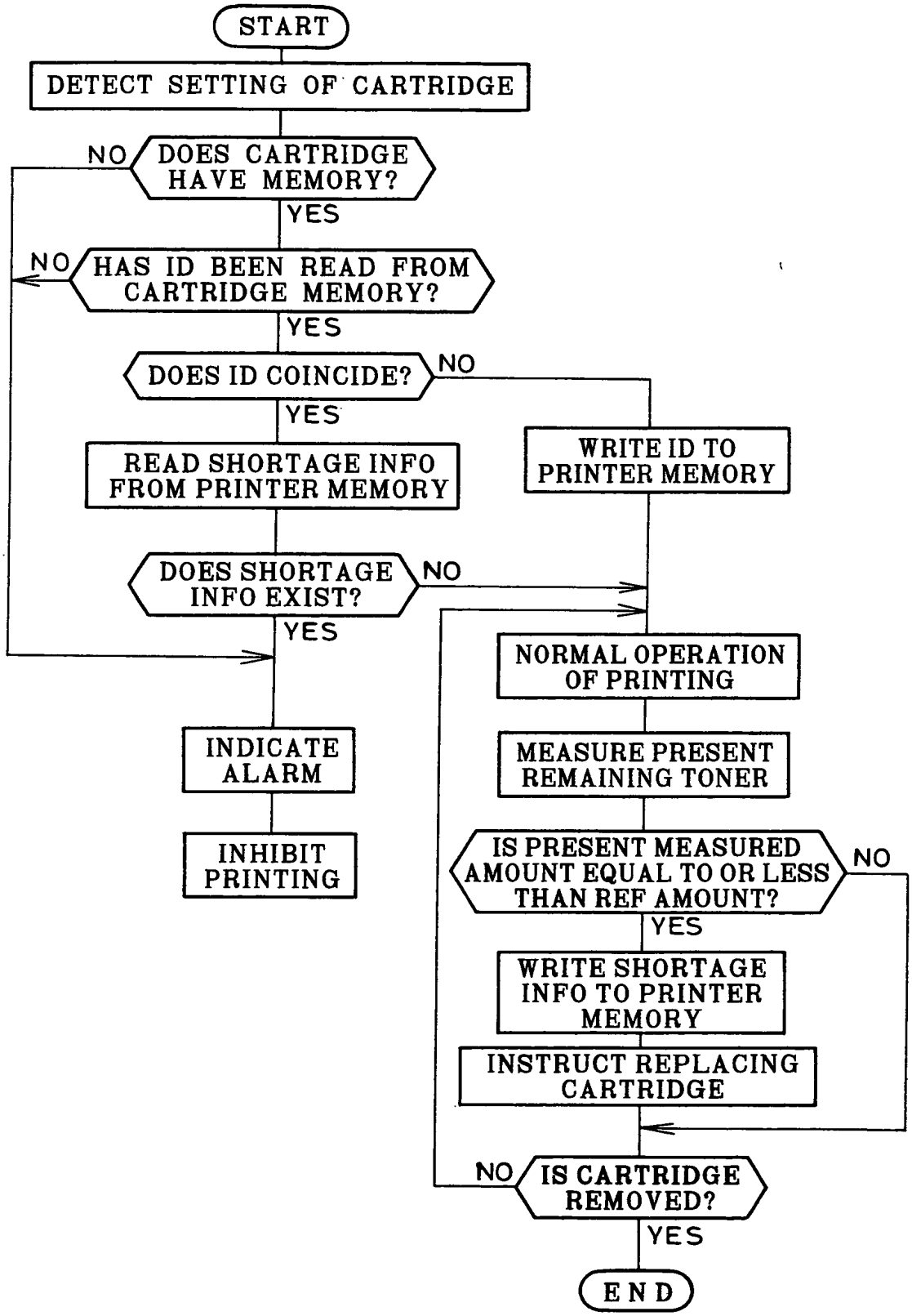

START
DETECT SETTING OF CARTRIDGE
DOES CARTRIDGE HAVE MEMORY?
NO
YES
HAS ID BEEN READ FROM CARTRIDGE MEMORY?
NO
YES
DOES ID COINCIDE?
NO
YES
READ SHORTAGE INFO FROM PRINTER MEMORY
WRITE ID TO PRINTER MEMORY
DOES SHORTAGE INFO EXIST?
NO
YES
INDICATE ALARM
INHIBIT PRINTING
NORMAL OPERATION OF PRINTING
MEASURE PRESENT REMAINING TONER
IS PRESENT MEASURED AMOUNT EQUAL TO OR LESS THAN REF AMOUNT?
NO
YES
WRITE SHORTAGE INFO TO PRINTER MEMORY
INSTRUCT REPLACING CARTRIDGE
IS CARTRIDGE REMOVED?
NO
YES
END

FIG. 18

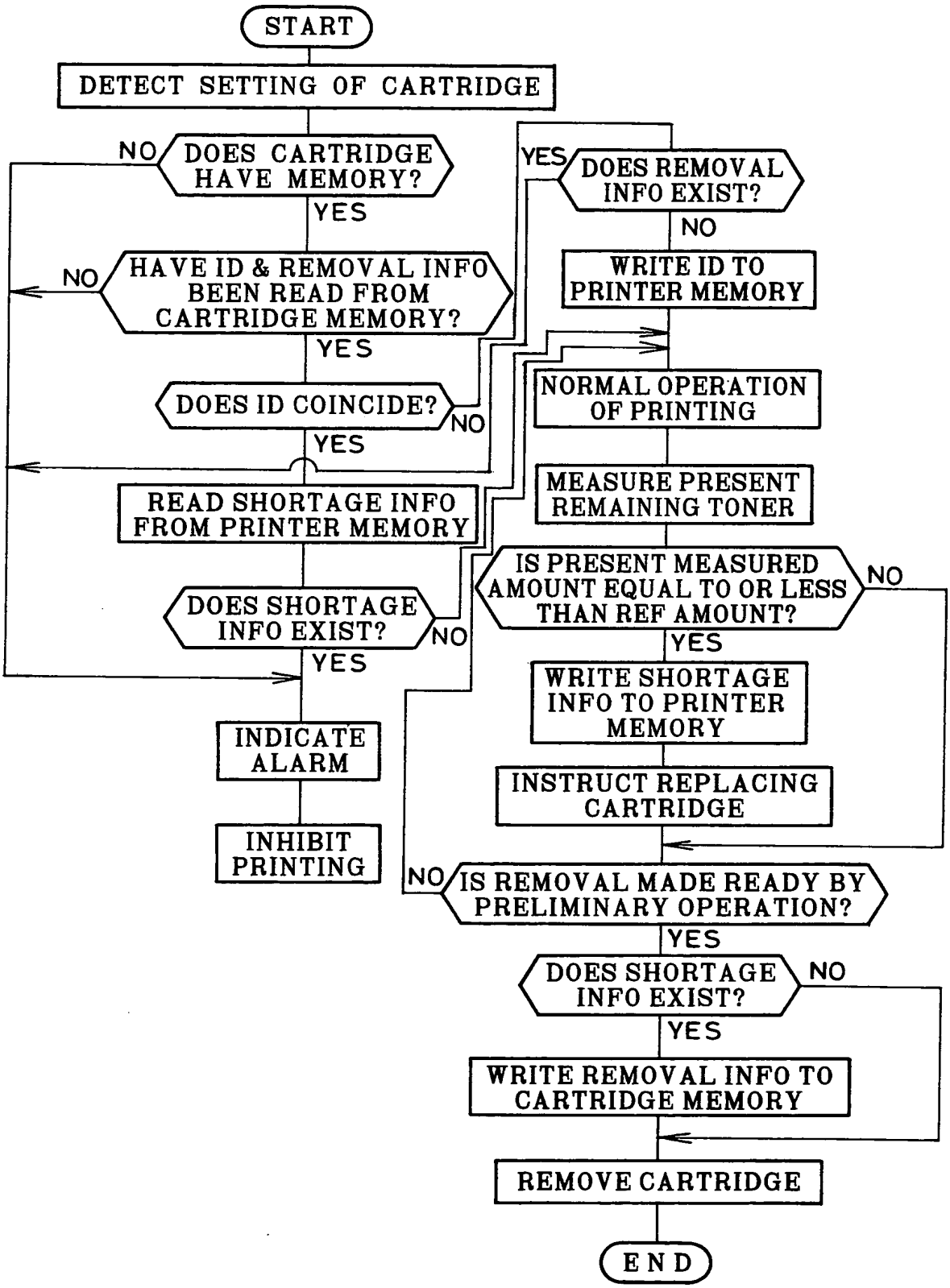

START
DETECT SETTING OF CARTRIDGE
DOES CARTRIDGE HAVE MEMORY?
NO
YES
HAVE ID & REMOVAL INFO BEEN READ FROM CARTRIDGE MEMORY?
NO
YES
DOES ID COINCIDE?
NO
YES
READ SHORTAGE INFO FROM PRINTER MEMORY
DOES SHORTAGE INFO EXIST?
NO
YES
INDICATE ALARM
INHIBIT PRINTING
DOES REMOVAL INFO EXIST?
YES
NO
WRITE ID TO PRINTER MEMORY
NORMAL OPERATION OF PRINTING
MEASURE PRESENT REMAINING TONER
IS PRESENT MEASURED AMOUNT EQUAL TO OR LESS THAN REF AMOUNT?
NO
YES
WRITE SHORTAGE INFO TO PRINTER MEMORY
INSTRUCT REPLACING CARTRIDGE
IS REMOVAL MADE READY BY PRELIMINARY OPERATION?
NO
YES
DOES SHORTAGE INFO EXIST?
NO
YES
WRITE REMOVAL INFO TO CARTRIDGE MEMORY
REMOVE CARTRIDGE
END

FIG. 19

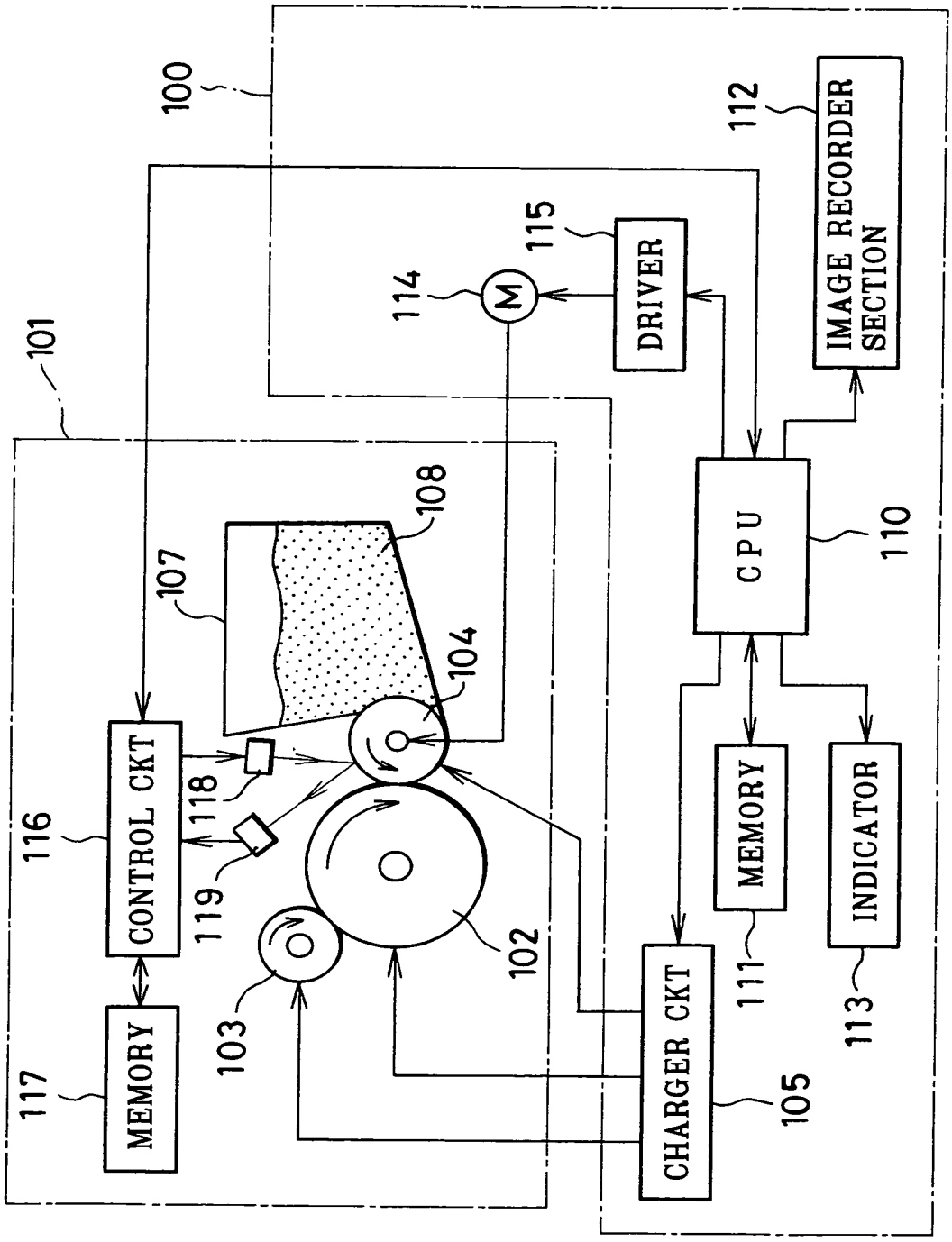

100
101
102
103
104
107
108
110
111
112
113
114
115
116
117
118
119
CONTROL CKT
MEMORY
CHARGER CKT
CPU
MEMORY
INDICATOR
DRIVER
M
IMAGE RECORDER SECTION

FIG. 20

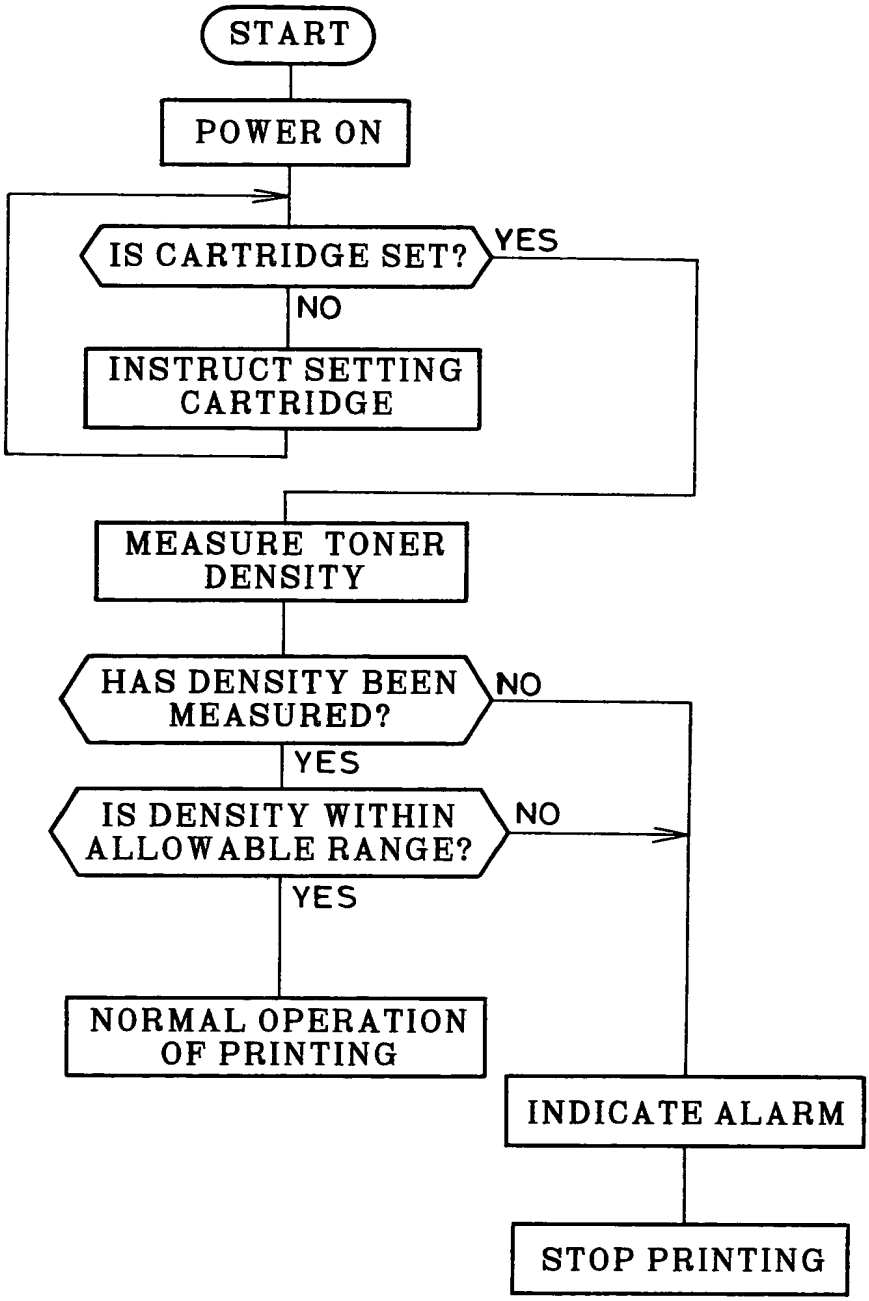

START
POWER ON
IS CARTRIDGE SET?
YES
NO
INSTRUCT SETTING CARTRIDGE
MEASURE TONER DENSITY
HAS DENSITY BEEN MEASURED?
NO
YES
IS DENSITY WITHIN ALLOWABLE RANGE?
NO
YES
NORMAL OPERATION OF PRINTING
INDICATE ALARM
STOP PRINTING

FIG. 21

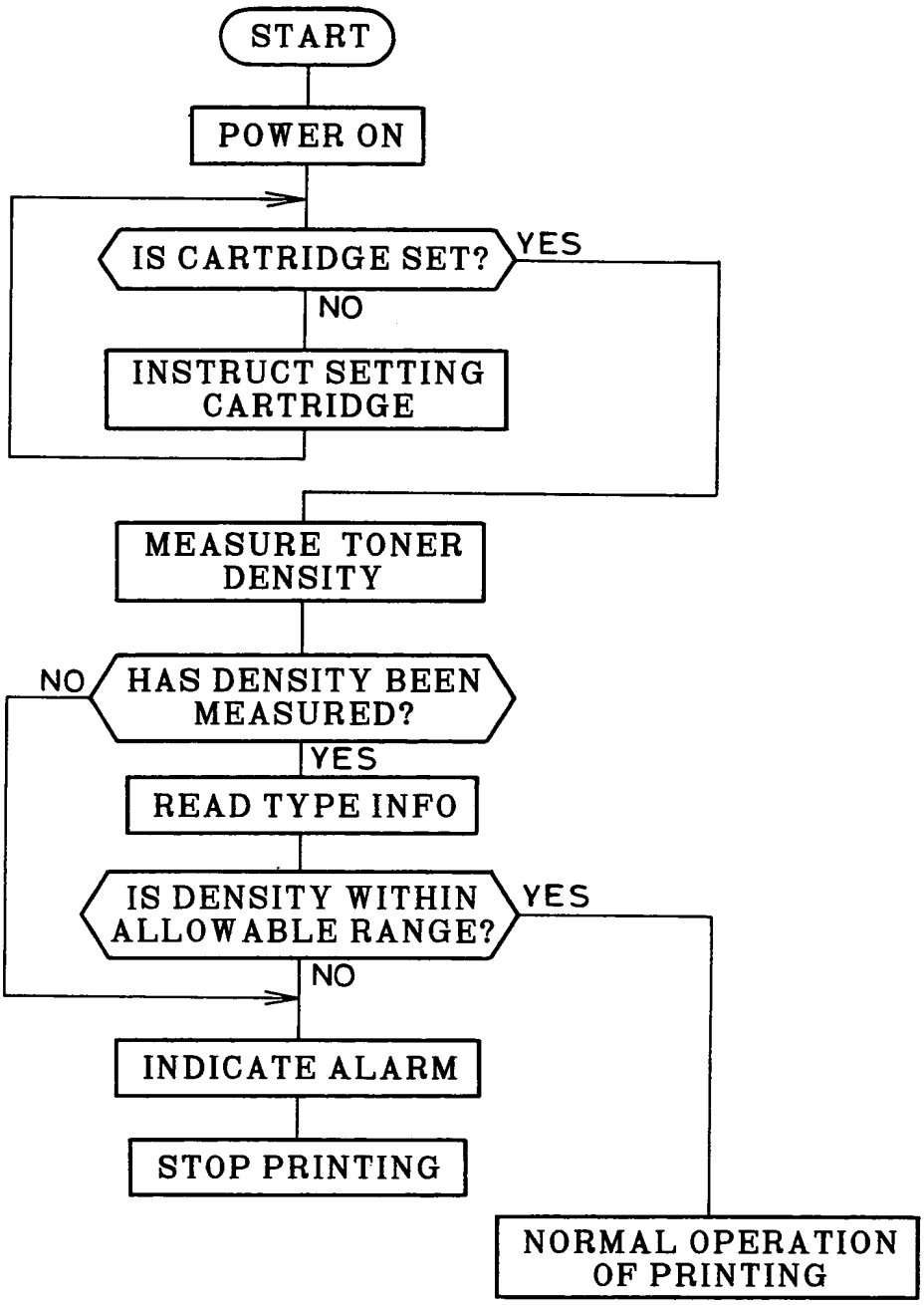

START
POWER ON
IS CARTRIDGE SET?
YES
NO
INSTRUCT SETTING CARTRIDGE
MEASURE TONER DENSITY
NO
HAS DENSITY BEEN MEASURED?
YES
READ TYPE INFO
IS DENSITY WITHIN ALLOWABLE RANGE?
YES
NO
INDICATE ALARM
STOP PRINTING
NORMAL OPERATION OF PRINTING

FIG. 22

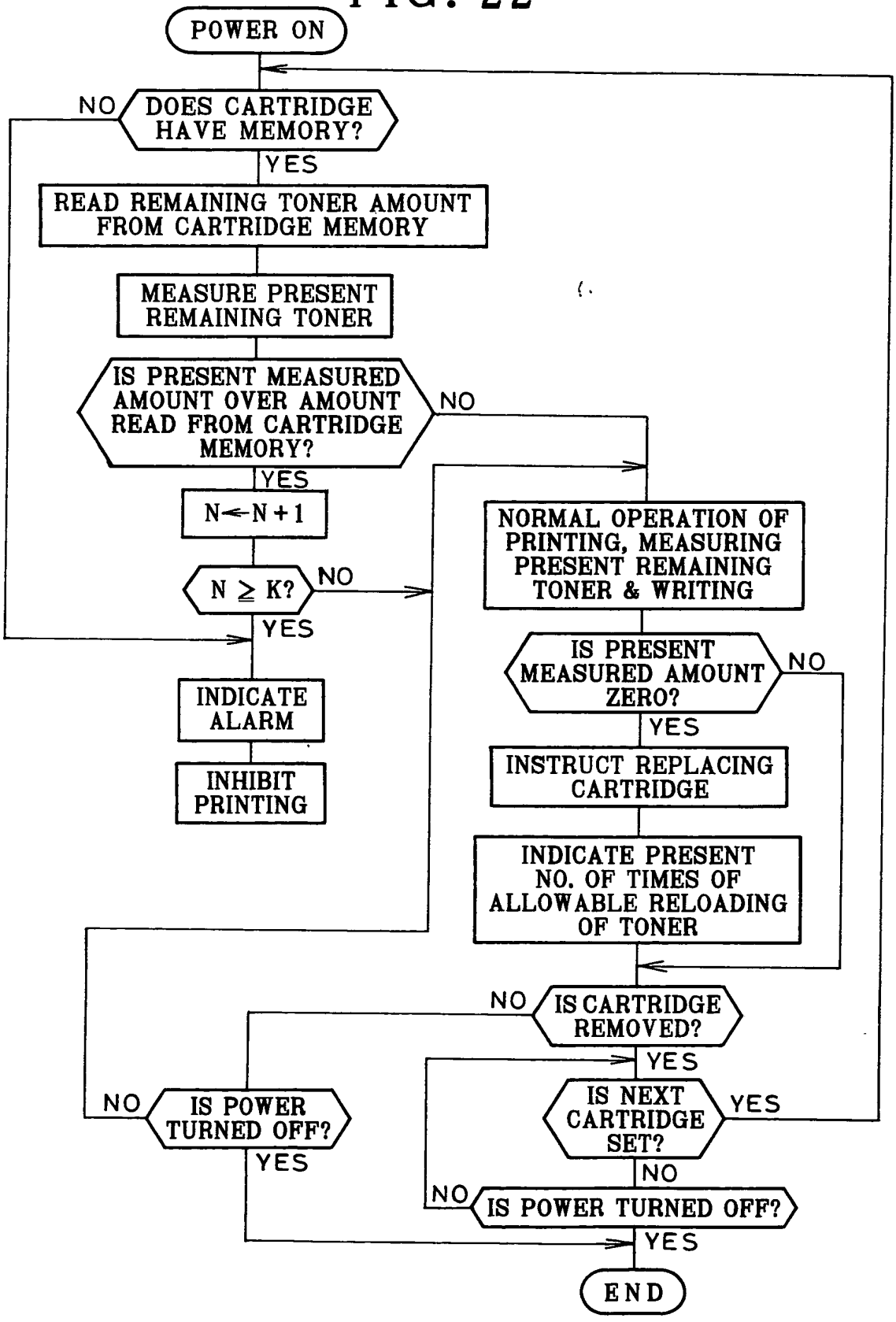

POWER ON
DOES CARTRIDGE HAVE MEMORY?
NO
YES
READ REMAINING TONER AMOUNT FROM CARTRIDGE MEMORY
MEASURE PRESENT REMAINING TONER
IS PRESENT MEASURED AMOUNT OVER AMOUNT READ FROM CARTRIDGE MEMORY?
NO
YES
N←N+1
N ≥ K?
NO
YES
INDICATE ALARM
INHIBIT PRINTING
NORMAL OPERATION OF PRINTING, MEASURING PRESENT REMAINING TONER & WRITING
IS PRESENT MEASURED AMOUNT ZERO?
NO
YES
INSTRUCT REPLACING CARTRIDGE
INDICATE PRESENT NO. OF TIMES OF ALLOWABLE RELOADING OF TONER
NO
IS CARTRIDGE REMOVED?
YES
NO
IS POWER TURNED OFF?
YES
IS NEXT CARTRIDGE SET?
YES
NO
NO
IS POWER TURNED OFF?
YES
END

FIG. 23

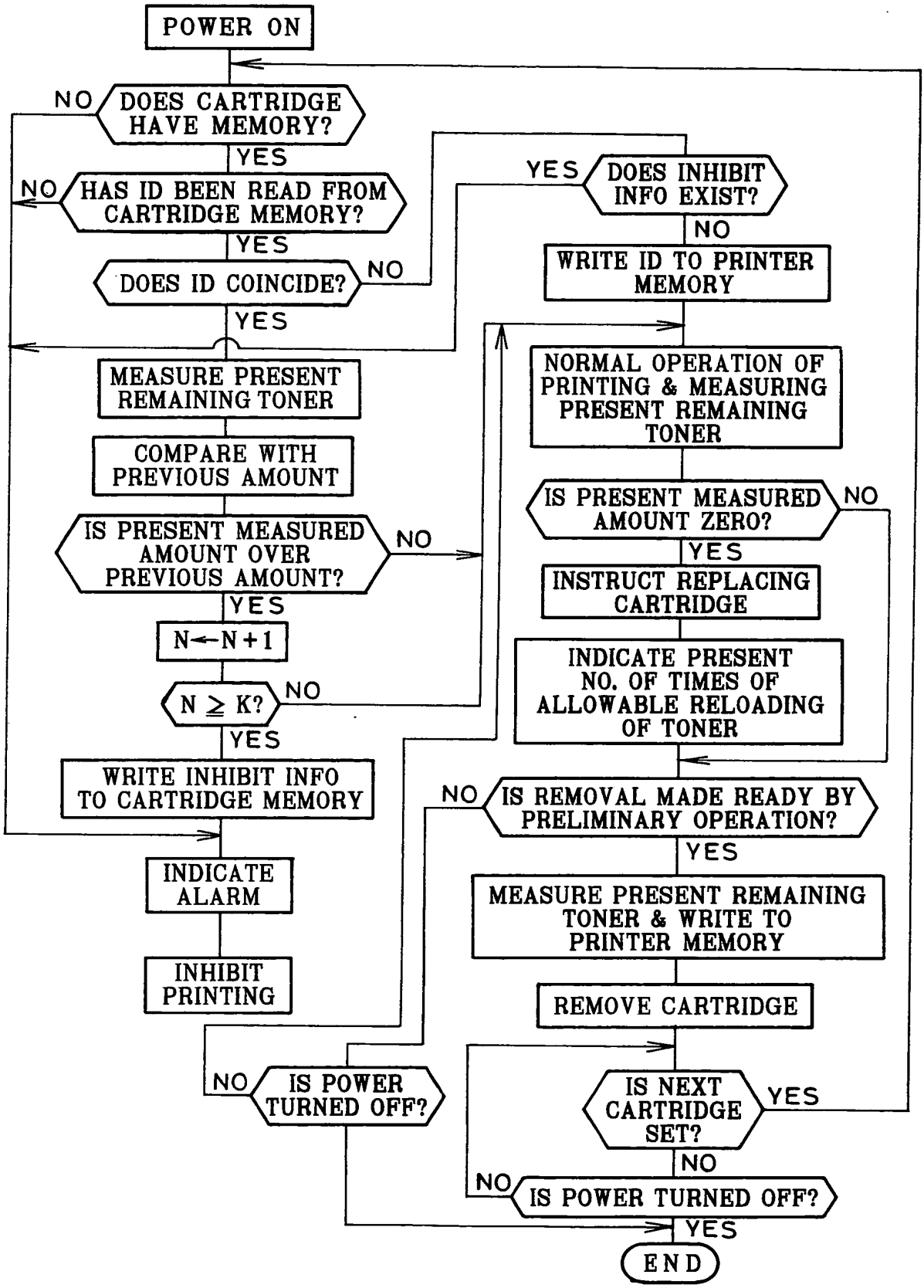

POWER ON
DOES CARTRIDGE HAVE MEMORY?
NO
YES
HAS ID BEEN READ FROM CARTRIDGE MEMORY?
NO
YES
DOES ID COINCIDE?
NO
YES
MEASURE PRESENT REMAINING TONER
COMPARE WITH PREVIOUS AMOUNT
IS PRESENT MEASURED AMOUNT OVER PREVIOUS AMOUNT?
NO
YES
N←N+1
N ≥ K?
NO
YES
WRITE INHIBIT INFO TO CARTRIDGE MEMORY
INDICATE ALARM
INHIBIT PRINTING
DOES INHIBIT INFO EXIST?
YES
NO
WRITE ID TO PRINTER MEMORY
NORMAL OPERATION OF PRINTING & MEASURING PRESENT REMAINING TONER
IS PRESENT MEASURED AMOUNT ZERO?
NO
YES
INSTRUCT REPLACING CARTRIDGE
INDICATE PRESENT NO. OF TIMES OF ALLOWABLE RELOADING OF TONER
IS REMOVAL MADE READY BY PRELIMINARY OPERATION?
NO
YES
MEASURE PRESENT REMAINING TONER & WRITE TO PRINTER MEMORY
REMOVE CARTRIDGE
IS NEXT CARTRIDGE SET?
YES
NO
IS POWER TURNED OFF?
NO
IS POWER TURNED OFF?
NO
YES
END

FIG. 24

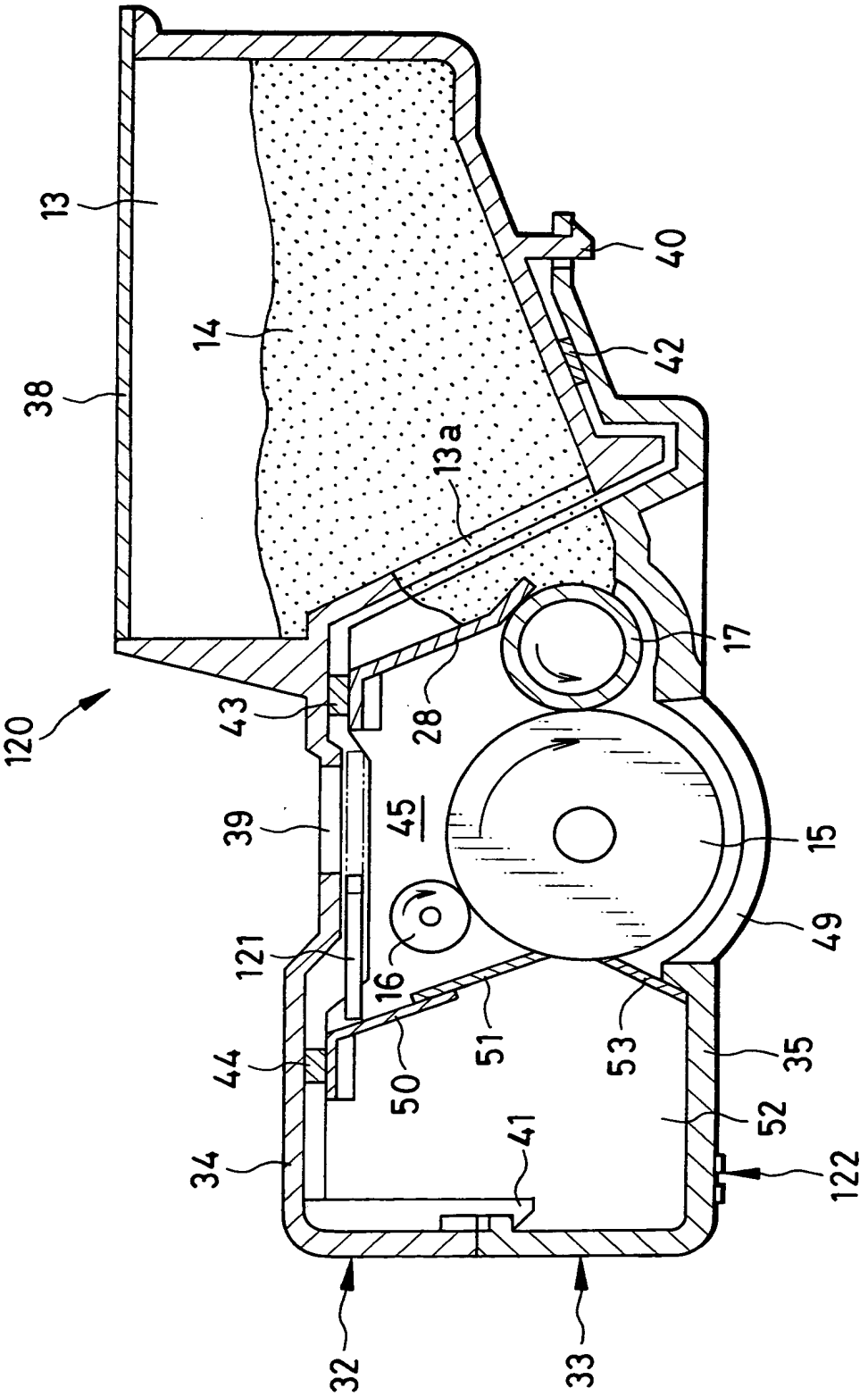

13
14
38
40
42
13a
17
120
43
28
39
45
15
121
16
49
44
50
51
53
35
52
34
41
122
32
33

FIG. 25

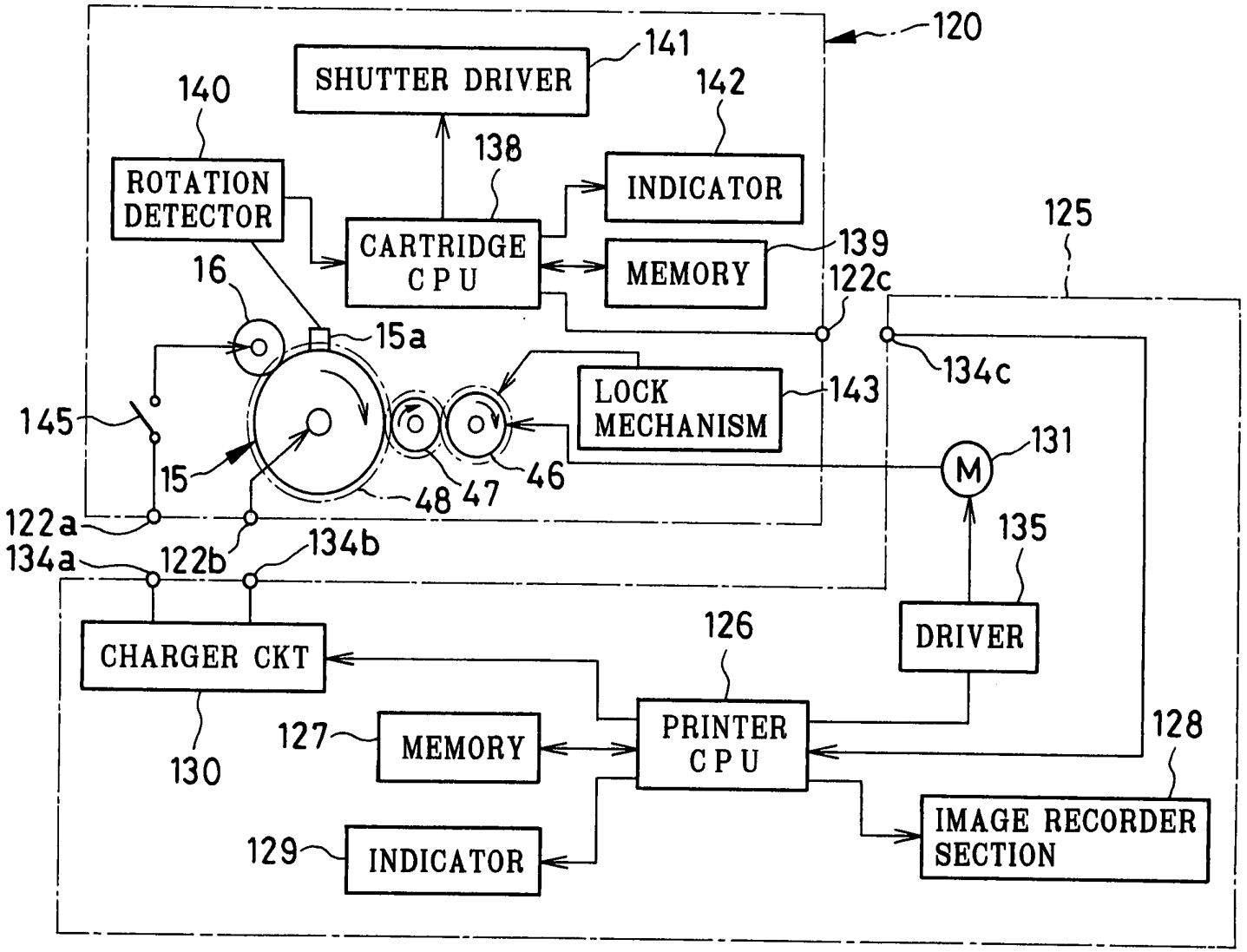

120
141
SHUTTER DRIVER
140
142
138
ROTATION DETECTOR
INDICATOR
CARTRIDGE CPU
MEMORY
139
125
16
122c
15a
134c
LOCK MECHANISM
143
145
131
M
15
48
47
46
122a
134a
122b
134b
135
DRIVER
126
CHARGER CKT
130
127
MEMORY
PRINTER CPU
128
IMAGE RECORDER SECTION
129
INDICATOR

FIG. 26

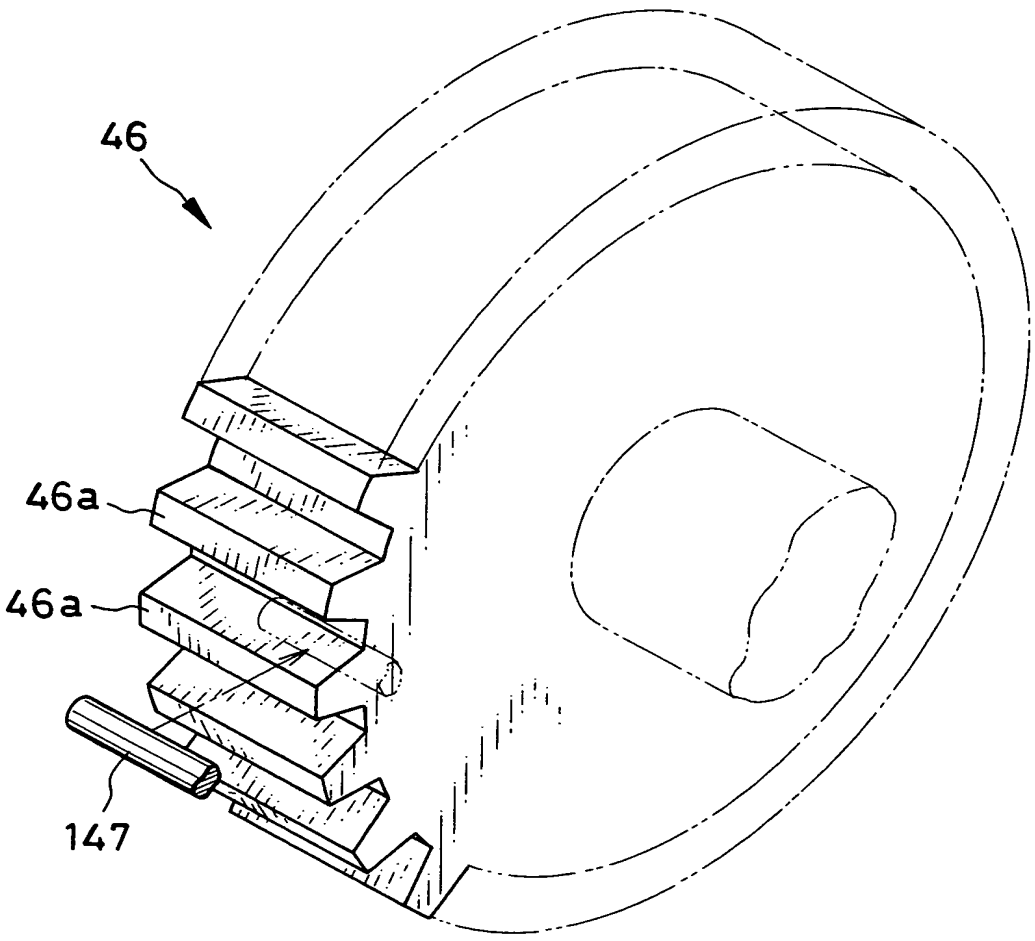


FIG. 27

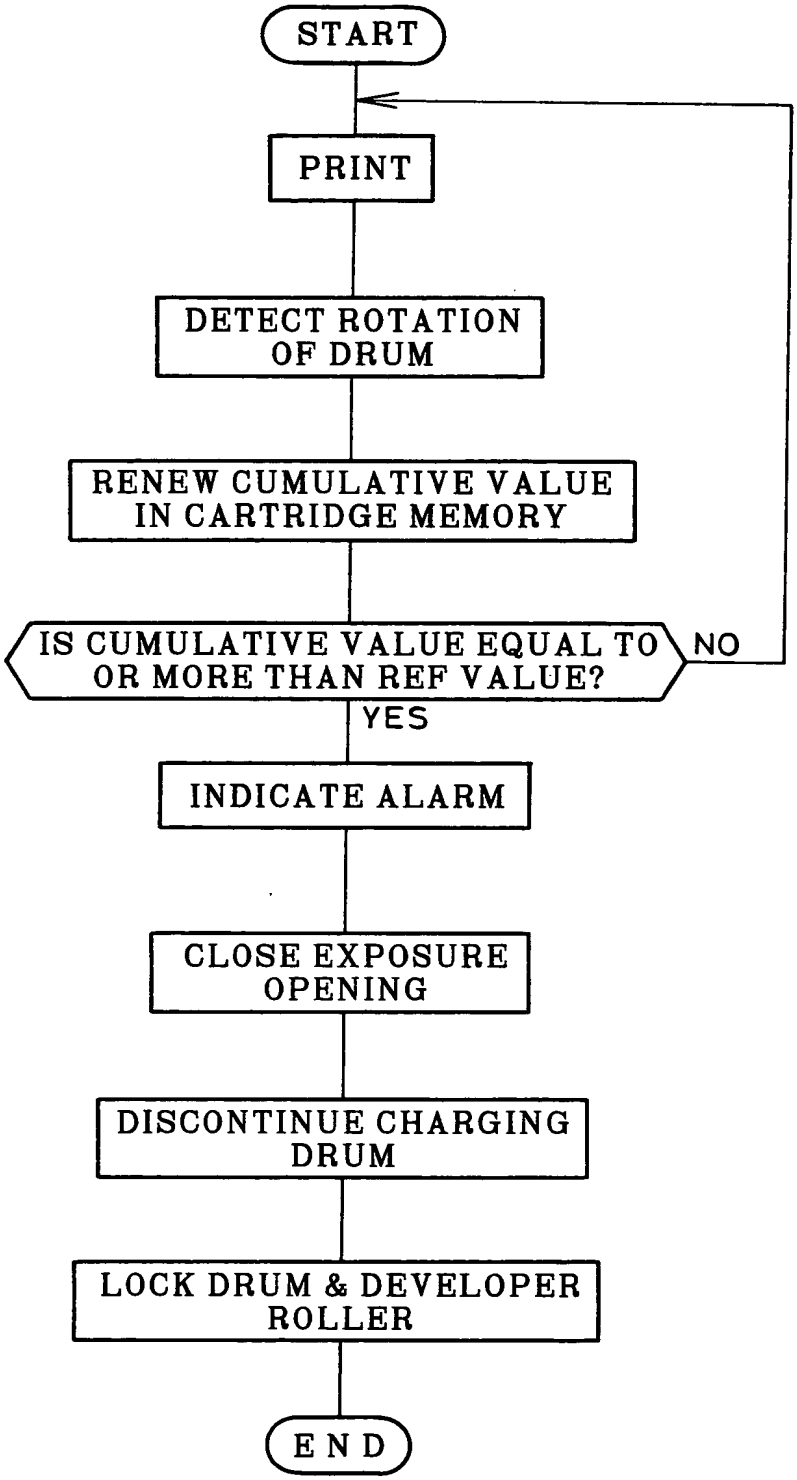

START
PRINT
DETECT ROTATION OF DRUM
RENEW CUMULATIVE VALUE IN CARTRIDGE MEMORY
IS CUMULATIVE VALUE EQUAL TO OR MORE THAN REF VALUE?
NO
YES
INDICATE ALARM
CLOSE EXPOSURE OPENING
DISCONTINUE CHARGING DRUM
LOCK DRUM & DEVELOPER ROLLER
END

FIG. 28

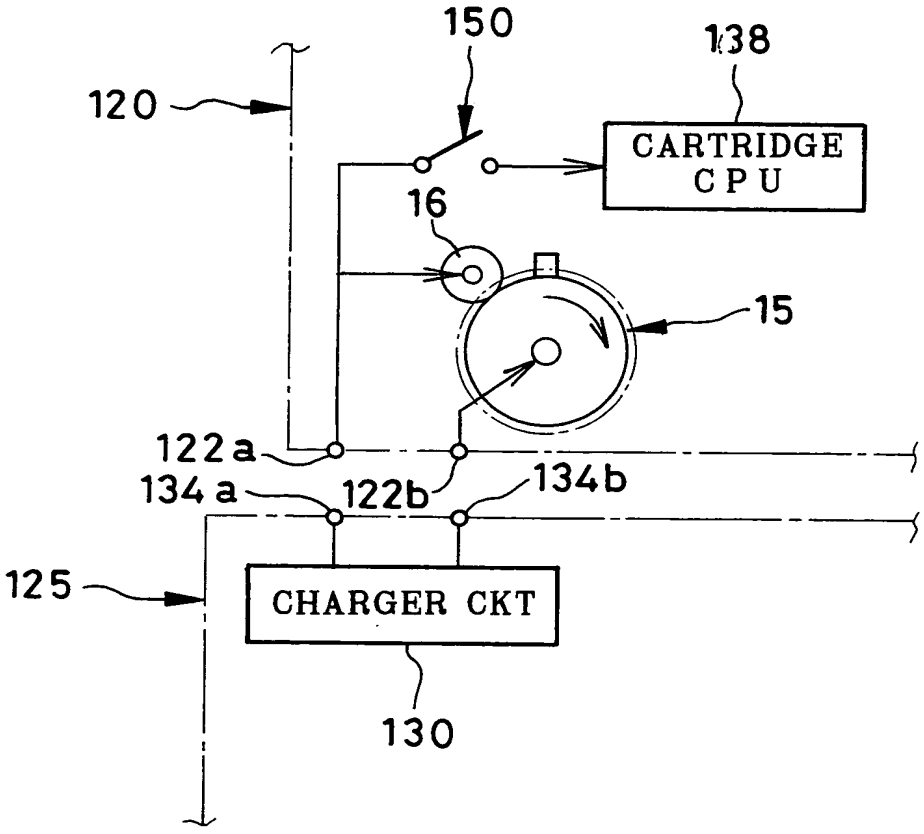

150
138
120
CARTRIDGE
CPU
16
15
122a
134a
122b
134b
125
CHARGER CKT
130

FIG. 29

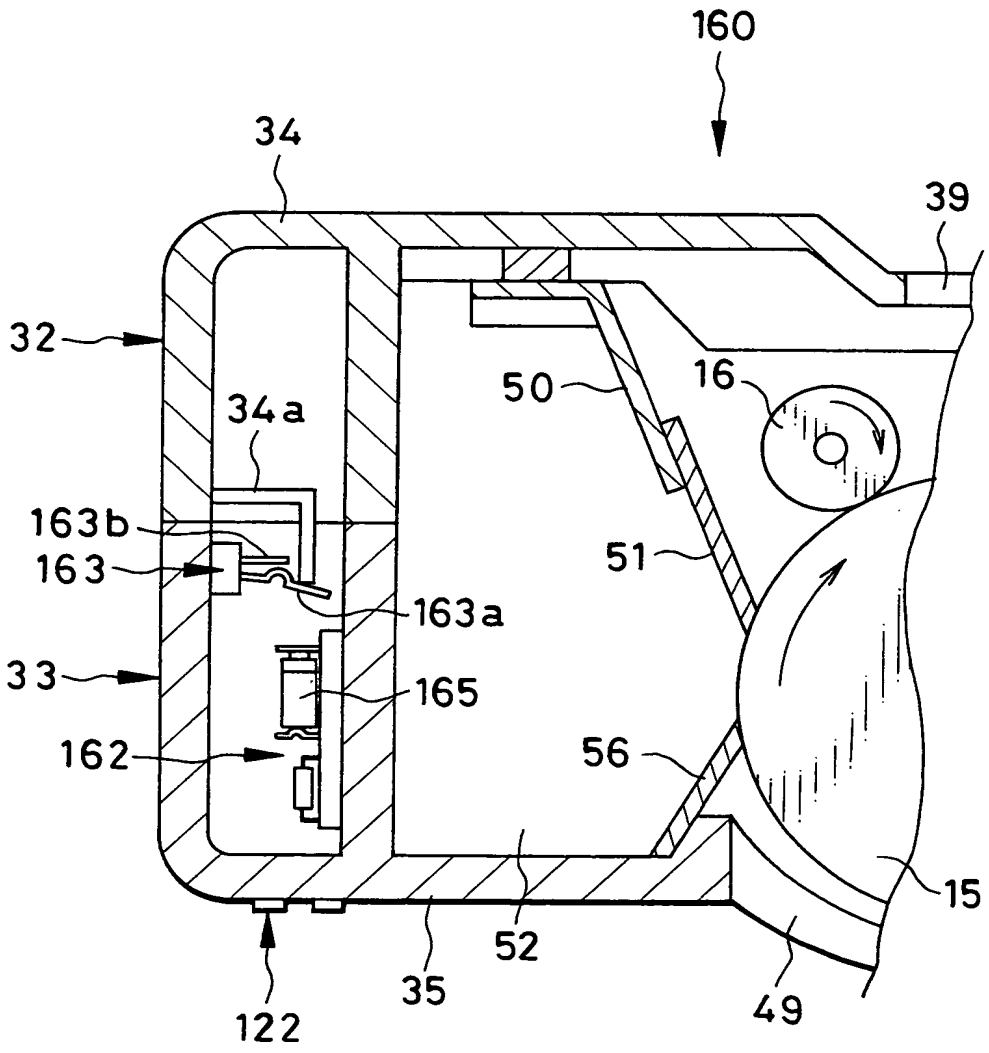

160
34
39
32
50
16
34a
163b
163
51
163a
33
165
162
56
15
52
35
49
122

FIG. 30

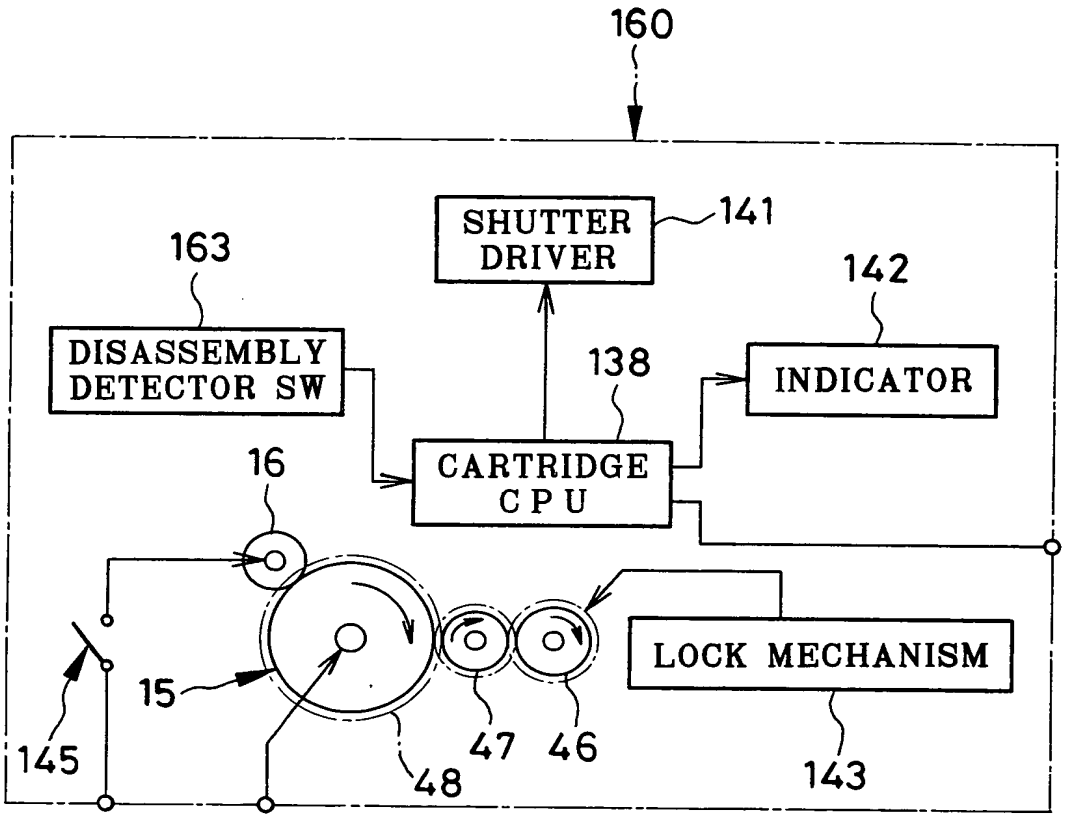

160
SHUTTER DRIVER
141
163
142
DISASSEMBLY DETECTOR SW
138
INDICATOR
16
CARTRIDGE CPU
LOCK MECHANISM
15
145
47
46
48
143

FIG. 31

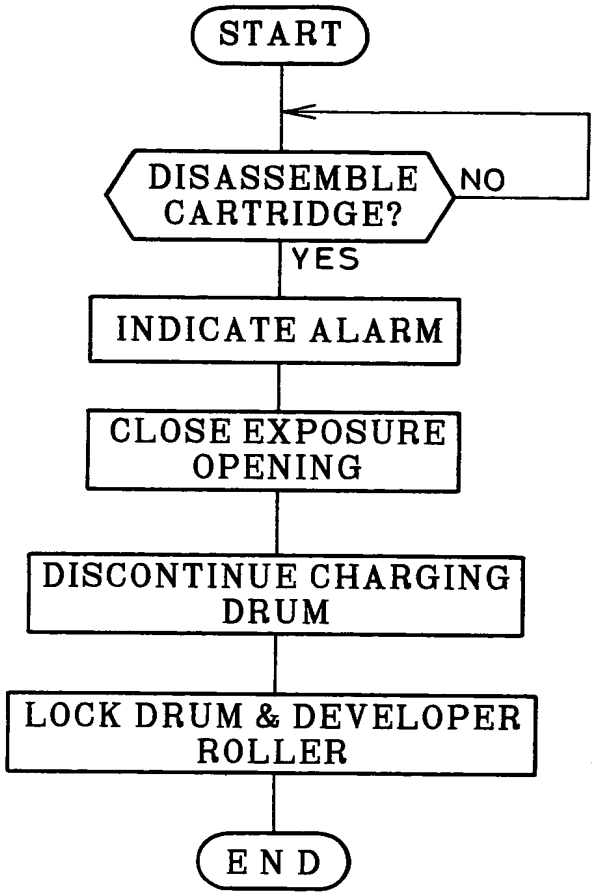
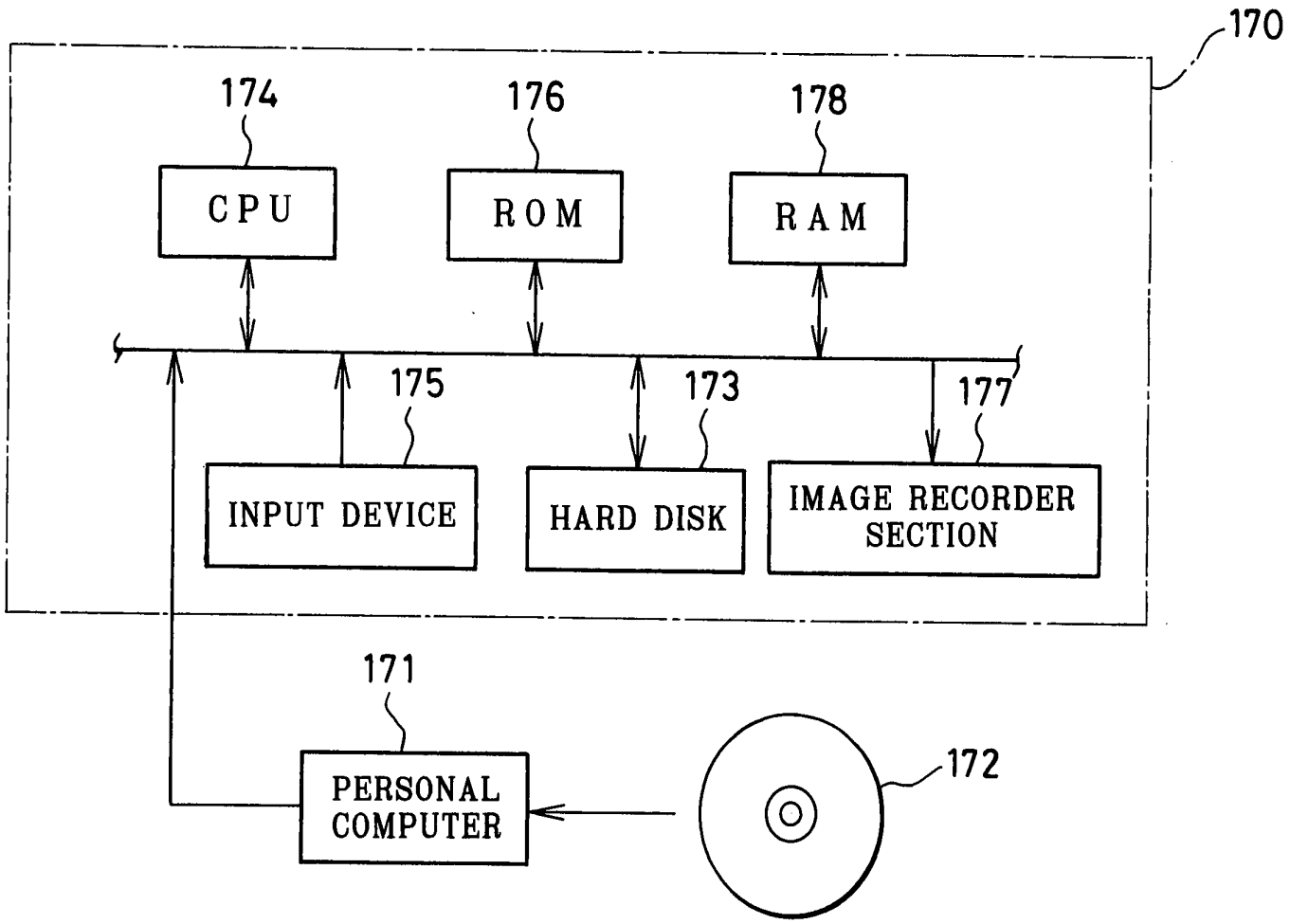

START
DISASSEMBLE CARTRIDGE?
NO
YES
INDICATE ALARM
CLOSE EXPOSURE OPENING
DISCONTINUE CHARGING DRUM
LOCK DRUM & DEVELOPER ROLLER
END

FIG. 32


170
174
176
178
CPU
ROM
RAM
175
173
177
INPUT DEVICE
HARD DISK
IMAGE RECORDER SECTION
171
PERSONAL COMPUTER
172